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In Your Experience: Pathways and Barriers for Female Students of STEM

Elizabeth J. Hartnett
University of South Carolina

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by

Elizabeth J. Hartnett

Bachelor of Science
University of Missouri, 1988

Master of Library and Information Science
University of South Carolina, 2004

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Accepted by:

Samantha K. Hastings, Major Professor

Allison D. Anders, Committee Member

Karen W. Gavigan, Committee Member

Elise C. Lewis, Committee Member

Cheryl L. Addy, Vice Provost and Dean of the Graduate School

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Abstract

This study addresses the gender gap that exists in the STEM professions. The number of jobs in STEM is climbing rapidly, but participation by women is disproportionately low. Although they make up roughly half of the overall population, women account for only about one quarter of the STEM workforce. A similar gap exists among undergraduates majoring in STEM fields. This is an exploratory study intended to identify and explore factors contributing to this gender gap, as perceived by undergraduate students. Through an online survey and follow-up interviews of undergraduates at two universities in the southeastern United States, data were collected to provide in depth information on specific experiences participants consider to be influential with regard to their decision to pursue or abandon a career in STEM. Themes identified in the findings aligned closely with several ideas from research in Education, including the importance of a sense of belonging and personal agency to success and healthy development.

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Chapter 1 -Introduction

Background

Females are underrepresented in occupations relating to the STEM (science, technology, engineering, and mathematics) disciplines. This has been true historically and persists in the present day. A primary reason for this is societal norms that have discouraged girls from pursuing an interest in these fields, identifying them as more appropriate for males. The long-held stereotype that boys are better than girls at math and science continues to do its damage to the confidence of female students in their own abilities, as well as the expectations held for them by many of the important adults in their lives.

Social norms and expectations exert significant influence on girls' attitudes toward STEM, and the problem extends well beyond childhood. Girls and boys all receive similar exposure to STEM-related courses in high school, yet female students are much less likely than male students to choose these subjects as their college major (Chen, 2009). By graduation, women earn just 20% of the bachelor's degrees awarded in the areas of physics, engineering, and computer science. The drop-off in representation continues into graduate school and the workplace (Hill, Corbett, & St. Rose, 2010). In recent years, women made up less than one-quarter of U.S. university faculty in computer and information sciences (22 %), math (19 %), the physical sciences (18 %), and engineering (12 %). (Di Fabio, Brandi, & Frehill, 2008).

In response to the growing need for skilled STEM employees as well as the underrepresentation of females in STEM occupations, educators and community organizations provide programs intended to foster an interest in STEM among girls. A range of national organizations, including the National Aeronautics and Space Administration (NASA), the American Association of University Women (AAUW), and the Girl Scouts undertakes major initiatives promoting the participation of girls in STEM-related activities. Museums, libraries, and other cultural institutions incorporate programs and create facilities that encourage the exploration of STEM subjects through activities designed to foster experimentation and problem solving. Many school districts are designing instruction and facilities specifically intended to encourage the development of STEM skills and interests in students (Hill et al, 2010).

There has been encouraging progress in terms of increasing the number of females working and studying in some STEM fields, so at least some of these efforts have the desired effect (Hill et al, 2010). In 2016, for the first time in its history, Dartmouth awarded more bachelor's degrees in Engineering to females than males. Of the 119 degrees awarded, 64 were to women. The school's dean attributed this to the practice of providing entry-level engineering courses to students across disciplines, as well as "building a diverse population of role models" in the school (Trustees, 2016). At the University of Texas, the number of women earning Engineering degrees more than doubled in the decade between 2006 and 2016. Despite this growth, the overall percentage of engineering degrees awarded to women there remains disproportionately low: 22%, with certain areas, like Electrical/Computer, Aerospace, and Mechanical Engineering seeing rates in 2015 that ranged from five to 16%. (Cockrell, 2016).

As these efforts to encourage female participation in STEM continue, it would be useful to know more about what experiences the students themselves have found to be most helpful, and also what they perceive to be the major barriers that remain on their path to STEM careers.

A 2013 report (Mosatche, Matloff-Nieves, Kekelis, & Lawner, 2013) describes three such programs used with thousands of middle school girls in an outside-of-school time (OST) setting, offering both after-school and summer activities. These include Techbridge, Girls Go Techbridge, and Access for Young Women (AFYW). Techbridge originated in California, and was launched with a National Science Foundation grant in 2000. It was expanded in 2008 with the cooperation of the Girl Scouts to include 13 states (for Girls Go Techbridge). AFYW is a leadership program conducted by the Queens Community House in New York City, which added a STEM emphasis beginning in 2005.

Activities included in these programs were work on collaborative projects, lessons on incorporating the scientific method in everyday life, research activities, and career information. Survey data from participants in these programs indicated improvements in technology skills, the ability to use data in research, and presentation skills. Most significantly, the participants' attitudes toward STEM careers often shifted: in the Go Girls Techbridge survey, twice as many participants indicated an intention to pursue a career in engineering at the end of the program as at the start (Mosatche et al., 2013).

Research Questions. To examine the problem of the underrepresentation of women in STEM, it is useful to understand the experiences that have a positive or negative impact on a girl's intention to work in those fields. The proposed study seeks to

uncover these experiences, and to investigate whether the cognitive style of participants is related to their career choice. Research questions include:

- What experiences encourage female students to pursue an interest in STEM fields?
- What barriers do female students pursuing an interest in STEM perceive?
- Is there a relationship between cognitive style and career choice?

Definitions. One of the first steps in conducting the study was to clarify which subject areas would be included under the umbrella of STEM. There is no universally accepted list, and this can make comparing statistics from different sources problematic. The search for an appropriate list yielded a number of candidates, including lists from the Bureau of Labor Statistics (BLS), the National Center for Education Statistics (NCES), the National Science Foundation (NSF), and even the Department of Homeland Security (DHS). These lists all had some overlap, but none were identical.

The DHS list has the broadest definition of STEM, which encompasses 22 disciplines, including areas such as Communications, Psychology, and Education. This list is used in determining whether international students are eligible to remain for 17 months of additional training after graduation. This extension is granted to students in the fields designated as STEM by the DHS. The list of STEM subjects compiled by the NSF also includes Social Sciences and STEM Education. While it does include life sciences such as Physiology, Genetics, and Immunology, the list makes no explicit mention of programs such as Nursing, Medicine, or Allied Health. Both the NCES and the BLS include health sciences and health occupations in their description of STEM disciplines.

For this study, the list provided by the NCES was used as a guide for categorizing subjects as either STEM or Non-STEM. Its four categories: mathematics, natural sciences, engineering, and computer/information sciences include the core disciplines associated with STEM, as well as health sciences and technologies (Cunningham, Hoyer, & Sparks, 2015).

Another important term to define for the study is cognitive style. For the purposes of this study, cognitive style is defined as the way an individual person perceives, thinks, solves problems, learns, and relates to others. This definition was first presented by Witkin, Moore, Goodenough, and Cox (1977) in the late 1970's, in their work on the implications of cognitive style for education. Their research examined the influence of cognitive style upon how students learn as well as how teachers teach, at both the K-12 and higher education levels.

Cognitive styles are generally considered to be arranged along a continuum, with analytical tendencies (sometimes called field-independent style) seen as opposite to the inclination toward less linear thinking and more reliance upon intuition (also called "field-dependent style). A person's cognitive style influences how they approach a problem or task, but no specific cognitive style is considered to be indicative of superior intelligence. There has however, been some evidence to indicate that cognitive style may be related to career choice.

A recent descriptive study in Nigeria looked for relationships between cognitive style and several other variables, including career choice among secondary students at 16 schools. Their data show a significant relationship between cognitive style and career choice among participants. There was also a tendency for males to be identified as field-

independent more often than females, and the researchers attributed this to "cultural stereotypes." (Onyekuru, 2015).

Significance

Although extensive research over the last 25 years has targeted the need to increase female participation in STEM and the reasons that need exists, progress has been painfully slow. As success stories mount, it will be useful to understand what experiences females engaged in the STEM fields find to be most helpful and what barriers they currently perceive. This information can inform the work of educators, cultural institutions, and community groups aiming to encourage the participation of females in STEM.

Understanding the relationship between cognitive style and career choice may be one way to assess the impact of social norms and expectations on female students' pursuit of an interest in STEM fields. In other words, it may clarify how significant those forces are in changing the chosen path of an individual away from one that is aligned with their cognitive style. This information may also help to clarify the continuing prevalence of Implicit Biases, and the importance of working to change them.

Chapter 2 -Literature Review

To establish the proposed study's context, this section examines the body of literature that guides this study, including statistics and related findings in several areas. First, it discusses the rising demand for skilled workers in the STEM fields and the disproportionally low percentage of women working in those fields. Subsequent sections deal with findings on social factors contributing to the situation, as well as theories that can be applied toward understanding it.

Growing need and opportunities in STEM

The Bureau of Labor Statistics reported in 2010 that STEM jobs increased at more than twice the rate of non-STEM jobs in the decade beginning in 2000, and projected that their growth would accelerate in the coming years. The same report shows that the average earnings for STEM workers exceed that of workers in other areas, regardless of education level (Langton, 2011). This situation presents an opportunity for well-paid jobs, but statistics indicate that we face a considerable shortage of skilled workers. This could be significantly ameliorated if female students chose to work in STEM professions at a similar rate to males.

As it stands, the number of available STEM workers of any gender is inadequate to meet the demand. Growth in STEM jobs over the last 10 years has been 3 times as fast as other occupations. The projected growth through 2018 is expected to be 17.0% for STEM jobs, compared with 9.8% for other areas (Langdon 2011). The National Science

Board (2012) reports that women represent just 26% of the workforce in science and engineering, despite the fact that they make up about half of the nation's college-educated workforce. What is known about factors that contribute to this situation is discussed below.

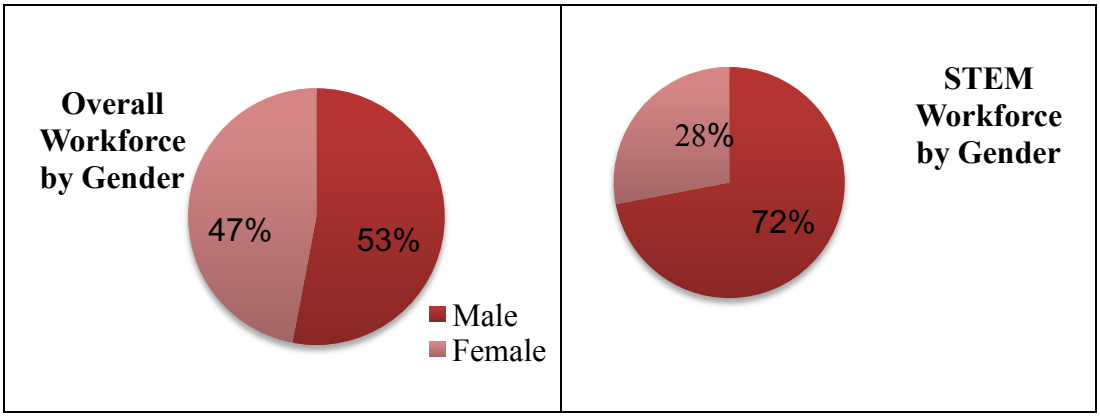


Figure 2.1. Gender Composition of Overall vs. STEM Workforce in the U.S.

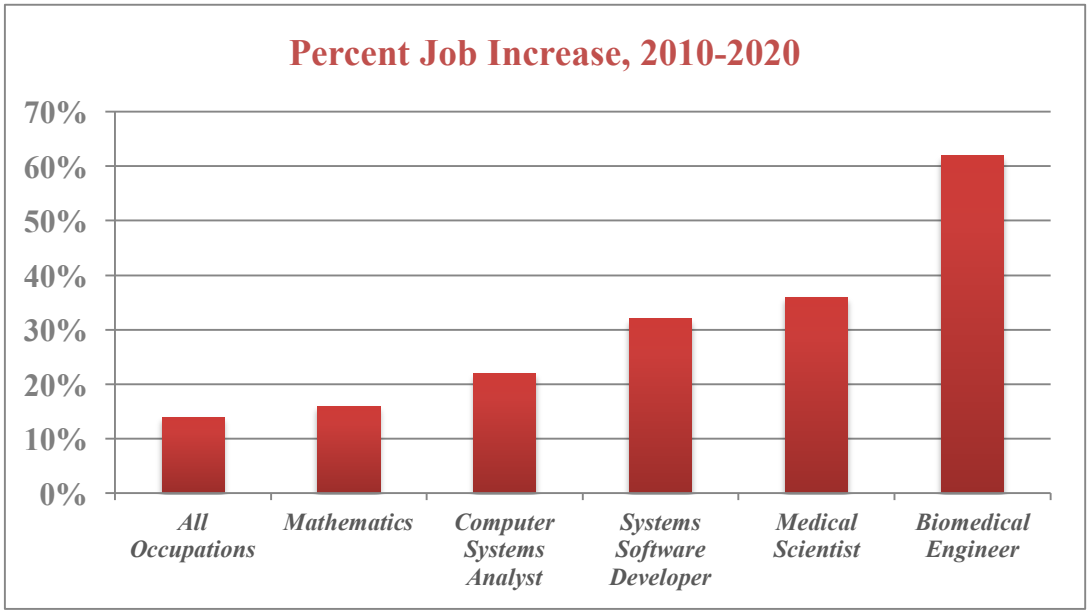


Figure 2.2. Projected Growth in Occupations 2010-2020.

Social and Environmental Factors

Research indicates the gender gap in STEM achievement is created by social and environmental factors (Hill et al., 2010). There is consistently a difference between boys' and girls' interest and feelings of confidence when it comes to STEM subjects. This can start at a very young age, and some evidence indicates that it is related to negative self-perception (Halpern et al., 2007).

Another important social factor in this discussion is Implicit Bias. Implicit Bias refers to the fact that all humans harbor prejudices of which they are not aware, but that nevertheless influence their choices and behavior. For example, even a woman working in a STEM field may have a subconscious inclination to view men as more suited to her position than women (Brownstein, 2015). Implicit Bias has an impact on career choices, and is created by our social environment (Handelsman & Sakraney, 2015).

Mentors

The importance of mentoring relationships to success in any field has been well documented. Research shows that girls benefit from relationships with role models and mentors (Holmes, Redmond, Thomas & High, 2012; Mosatche et al., 2013; Weber, 2011). In their 2012 study, Holmes, Redmond, Thomas, and High looked for correlations between middle school girls' overall confidence in science and mathematics with their experience in a year-long, afterschool mentoring program led by female university students majoring in engineering. They found that the girls' confidence levels were significantly related to the quality of the mentoring relationship.

The disproportionally low percentage of women working in STEM careers and faculty positions has an effect on the number of female students choosing and persisting

in these areas of study. By some calculations, women make up less than a quarter of the faculty at American universities across the range of STEM subject areas. Biology is the exception, with about 34% of faculty in that area being female (Hill, et al., 2010). As a result, female role models and mentors in the STEM fields can be few and far between.

Research shows that a major influence on the confidence of women in STEM fields is the presence of encouragement from influential individuals, including teachers and peers (Zeldin 2000). However, much of the research indicates that female students are likely to receive less feedback and encouragement from STEM faculty in college, who tend to subtly favor males. Among these tendencies, discussed by Grunspan et al (2016) is the fact that faculty members are more likely to spend time mentoring males, respond to emails from males, and call on males in class (Moss-Racusin 2012, Milkman 2014, Eddy 2014).

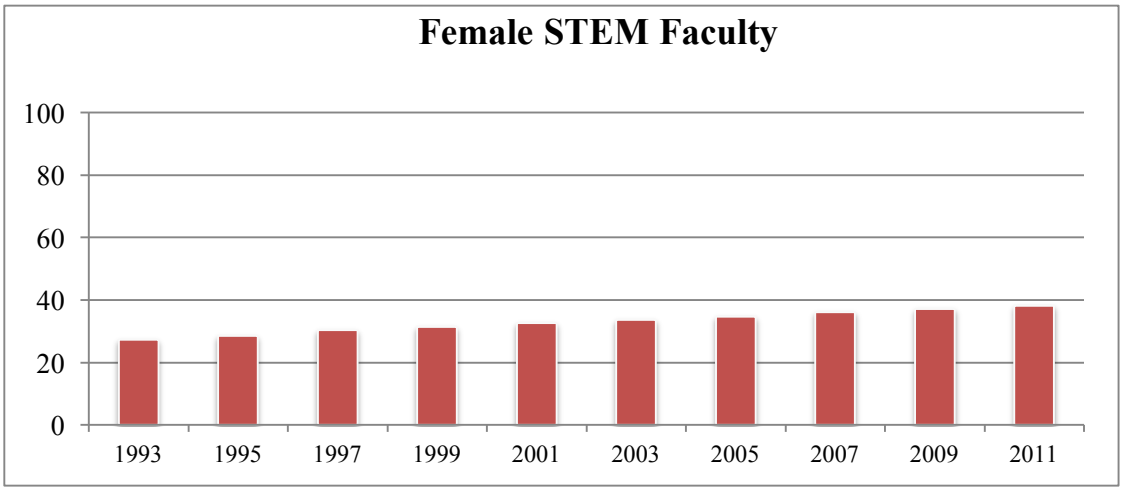


Figure 2.3. Postsecondary Female STEM Faculty 1993-2011

Attrition

While male and female students generally receive nearly equal exposure to STEM subjects through high school, the percentage of girls who choose STEM majors when they enter college is very low (Chen, 2009). Research into the reasons for this suggests that they include the institutional climate, faculty characteristics, support, and resources for STEM learning (Blickenstaff 2005; Fouad et al. 2010; Ost 2010). In work focusing particularly on female STEM undergraduates of color, Espinosa (2011) found the impact of the college environment to be especially significant on rates of attrition. Institutions in which these students were able to participate in a "robust community of STEM students" as well as in undergraduate research programs, helped female students of color to persist in their study of STEM subjects.

A recently published cross-disciplinary study examined how gender impacts students' perceptions of their peers with regard to subject mastery, in this case: Biology (Grunspan et al, 2016). The researchers explored the possibility that the social environment in the classroom contributes to higher attrition rates for female college students in the sciences. When asked to identify knowledgeable classmates, students of both genders were more likely to nominate males, even when their actual performance in the class did not support that opinion. The authors suggest that this bias might contribute to female attrition because of its negative effect on self-confidence, and in turn, performance. They listed three major influences on women's decision to leave a STEM field: sense of belonging, decision to start families, and confidence that one can succeed in the chosen profession.

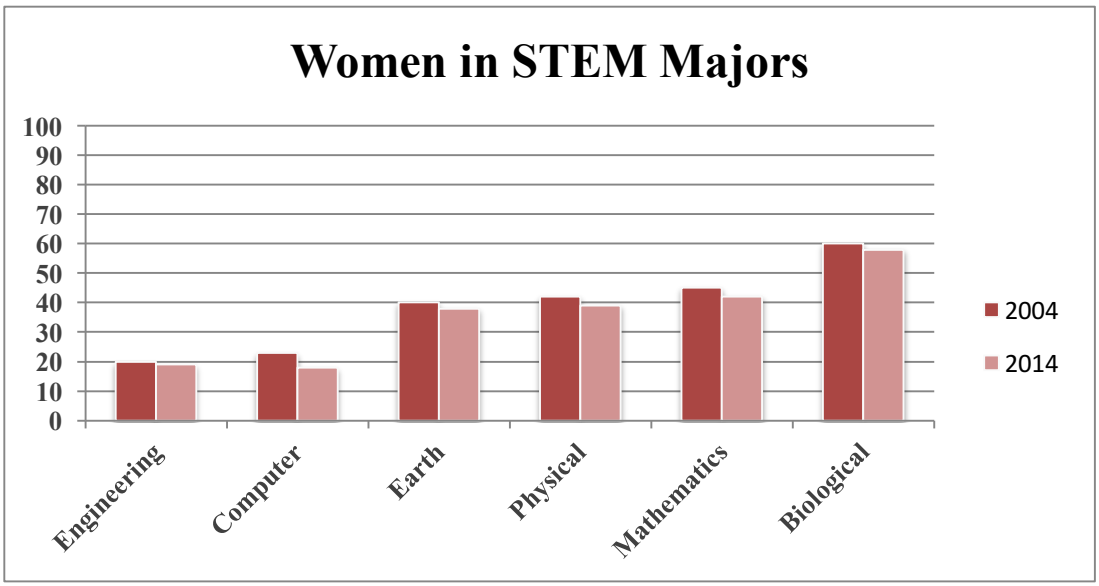


Figure 2.4. Female STEM Majors, 2004 versus 2014

A study currently underway at Stanford University, called Elephant in the Valley, gathers information from women in technology professions, primarily located in California's Silicon Valley (Vassallo, 2015). Surveys of over 200 professional women elicit their experiences in five major areas: Feedback & Promotion, Inclusion, Unconscious biases, Motherhood, and Harassment & Safety. Researchers are responding to the fact that, while women in technology fields are well aware of workplace disparities, they often come as a surprise to most men working in the field. Their findings show considerable gender discrimination as a common experience. For example, 66% of respondents reported being excluded from networking opportunities because of gender, and 88% said that they have been bypassed with questions. In other words, clients or colleagues have asked a male colleague questions that would best be answered by a female present. Researchers see this as an example of unconscious bias on the part of male colleagues. This study illustrates the fact that barriers for women in STEM extend far beyond the classroom.

Recognizing the barriers to female participation in STEM is just one part of the puzzle. Also relevant is information on what instructional approaches are most beneficial to girls in STEM subjects.

Resources and Instruction

Research indicates specific approaches to STEM instruction are effective in reaching female students in particular. Girls are motivated by open-ended, hands-on, and personally relevant projects that they can approach in their own style (Chatman, Boisnier, Spataro, Anderson, & Berdahl, 2008; Mosatche et al, 2013; Calabrese, Kang, Tan, O'Neill, & Brecklin, 2013). They gain confidence when they receive direct feedback on their effort and strategies (Halpern et al., 2007), and benefit from collaboration and communication (Werner & Denner, 2009).

Werner and Denner (2009) have studied the effects of working with a partner upon girls' performance in computer science courses. They found that students who worked with a partner "were more confident in their solutions, declared computer science–related majors more frequently, passed this and subsequent programming courses at higher rates, and produced higher-quality computer programs than students who worked solo." (p. 31) While this applied to students of both genders, the boost in confidence seen in women (24%) was much higher than that in men (15%).

Werner (2009) points to the value of partnerships in encouraging persistence in computer science on the part of female students: "Because working with a partner may also result in social support, it is a particularly promising strategy for improving the confidence, problem solving, and performance of students who do not typically persist or excel in computer science, such as girls" (p. 32).

Based on the research previously described, effective instruction for girls in STEM should involve collaboration, frequent communication and feedback, and relatively self-directed projects.

Relevant Theory

Ideas from the fields of Social and Educational Psychology help to explain how this imbalance in the STEM fields came to be. This section discusses how three major theories relate to the problem of underrepresentation of females in STEM. These relevant theories are Social Interdependence Theory, Implicit Bias, and Radical Change Theory.

Social Interdependence. Social Interdependence Theory explores the idea that how our goals are structured determines how we will interact, and in turn affects outcomes (Johnson, 2003). Positive Social Interdependence occurs when the individual's efforts are facilitated by interaction with others. It validates the idea that collaborative work can produce better results than individual or competitive frameworks for tasks. This theory has been tested and applied in educational research for decades, and certainly has implications for the design of programs intended to encourage female students in their pursuit of STEM subjects.

Given the information discussed above regarding instructional approaches that most benefit girls, it seems likely that positive social interdependence is essential for encouraging persistence in STEM among female students. Identifying activities and approaches that promote social interdependence would be one way to encourage more students to study STEM subjects.

Implicit Bias. Another important idea, briefly discussed above, is Implicit Bias, also known as Implicit Social Cognition. This describes the unconscious assumptions that

we all make as a result of our experience. These assumptions can run completely counter to our conscious opinions about things like gender and race, causing us to make decisions that do not necessarily reflect those opinions. (Statts, 2015).

This type of inner bias affects the choices that female students make in relation to career goals and what interests and skills they see as appropriate for themselves. The study of Biology students discussed above points to this sort of bias as a factor in attrition rates for female students of STEM. It also influences the attitudes they encounter from classmates, parents, and teachers. Research shows that male STEM majors in the U.S. strongly associate science and maleness. On the other hand, female STEM majors show a low level of Implicit Bias with regard to gender and science (Nosek, 2011).

Research has found that Implicit Bias is universal, but also malleable. It can be reduced through awareness and experience. There are methods for measuring Implicit Bias with regard to gender and subject areas specifically. The levels of this type of bias within an individual, as well as the bias they encounter among peers and mentors, could provide insight into reasons for selecting or not selecting STEM majors as a field of study.

Radical Change. Developed by Eliza Dresang in the 1990's, Radical Change Theory is often applied to the study of how young people learn and seek information, and how this changes in response to societal conditions. The theory identifies three ways that behavior changes: in terms of forms, perspectives, and boundaries. This certainly applies to the proposed study, which explores the perspectives of females with regard to STEM careers, and how their experiences and environment shape those perspectives. In order to play a larger role in the STEM fields, it may be necessary for girls to cross gender

boundaries that are only now being brought to light. While much of the research using Radical Change Theory has been related to information seeking behavior, it can provide a useful lens for examining how female students view themselves and others. It takes into account the need for interactivity, connectivity, and access that characterizes students in the digital age (Dresang, 2005).

The factors contributing to the gender gap in STEM are very complex, and relate to ideas from many disciplines. The research suggests several important factors that may influence girls to pursue or abandon their interest in STEM. One interesting idea to explore is whether these same factors emerge as themes in the data collected in the current study.

Chapter 3 -Methodology

As discussed in Chapter One, this study aimed to determine what experiences female undergraduates feel have encouraged them to pursue an interest in STEM and also what barriers they have encountered. These were examined in conjunction with the participants' cognitive style in order to discover what role they play in students' choice of career field.

The study addresses three questions:

- What experiences encourage female students to pursue an interest in STEM fields?
- What barriers do female students pursuing an interest in STEM perceive?
- Is there a relationship between cognitive style and career choice?

This chapter discusses the approach used in exploring these questions. It provides information on the tools and instruments used to gather data, which included the online survey, ALERT Scale, and follow-up interviews. The chapter concludes with a discussion of the study's limitations.

Approach and Data Gathering

This study is exploratory in nature, and seeks to identify the variables that influence girls in their decision to pursue an interest in STEM fields. The study utilizes surveys, interviews, and content analysis to elicit and analyze information from undergraduates of various majors at the University of South Carolina and at the University of North Carolina at Greensboro.

Setting and Participants

Study participants were undergraduate students of both genders with various majors at two universities: The University of South Carolina in Columbia, South Carolina, and The University of North Carolina at Greenville. These settings were chosen for their proximity and the likelihood of access to student participants. Those participants were selected through convenience sampling, defined as sampling that involves drawing samples that are both easily accessible and willing to participate in a study (Yu, 2007). Participants were identified through working with contacts at both universities willing to administer the online survey to their students.

	University of South Carolina-Columbia	**University of North Carolina-Greensboro**
City population[a]	134,000	280,000
Undergraduate Enrollment[b]	24,000	16,000
Gender split[c]	Males 45.9 %, Females 54.1	Males 34%, Females 66%
Courses in sample	SLIS 202	ENG 101

[a] U.S Census Bureau
[b] http://ipr.sc.edu/enrollment/prel2016/spring/freeze.pdf and http://admissions.uncg.edu/discover-about.php
[c] http://colleges.usnews.rankingsandreviews.com/best-colleges/university-of-south-carolina-3448/student-life.

Figure 3.1 Comparison of study settings

With the assistance of two instructors at the University of South Carolina and one from the University of North Carolina at Greensboro, 121 survey participants were identified. These were all undergraduate students, and were enrolled in either SLIS 202, Introduction to Information Literacy and Technology (at South Carolina) or English 101 (at North Carolina). These courses were chosen because they are open to all majors and

would provide a broad cross-section of the student body and would more likely result in a heterogeneous sample.

The survey participants ranged in age from 18 to 45, with the average age falling at 20 years. That matches the average age for all undergraduates at the University of South Carolina, as reported in 2015, and is very close to UNCG's average undergraduate age of 21 years. (University of South Carolina, 2015; College Portrait, 2015).

Just over half of the survey respondents (57%) were white and 27% were African-American. Just 6% of the students responding reported their ethnicity as Asian, 5% Hispanic, and less than 1% chose either Native American or Pacific Islander. This distribution of ethnicities fairly closely reflects the overall population of the region (see Figure 3.2).

Ethnic Identity	Survey	South Carolina	North Carolina
White	57%	68.4%	71.2%
Black	27%	26.7%	22.2%
Asian	6%	1.6%	2/8%
Hispanic	5%	5.5%	9.1%
Native American	<1%	0.5%	1.6%
Pacific Islander	<1%	0.1%	0.1%

Figure 3.2 Ethnicity of Survey Respondents compared with Overall State Populations

Survey respondents were also fairly well distributed along gender lines, with 72 (59.5%) of the 121 respondents self-identifying as female, and 48 (39.6%) male. One respondent preferred not to identify as one gender or the other.

The percentage of male participants who reported a major in a STEM field was 38, slightly higher than the 32% of female participants who were STEM majors.

Initial Survey

The first step in data gathering was administration of an online survey using the Qualtrics platform. A pilot was administered in March of 2016 to test the survey. Pilot participants were recruited from the SLIS 201 class at the University of South Carolina. The following section summarizes the findings of this pilot survey and discusses the adjustments that were made to the instrument as a result.

The survey pilot. A pilot was conducted in March 2016 to test the survey instrument. This section summarizes the results of this test, with information relating to the various areas addressed by the survey questions and the results of the ALERT Scale of Cognitive Style. The ALERT scale was developed in 1989 by Dr. Lauren D. Crane of Western Michigan University, and is widely used among researchers in the fields of Education and Psychology. The scale has been used in psychological evaluations, to examine how educators determine their instructional approach, and also as a tool for human resource departments in recruiting and selecting the workforce in a variety of occupations (Poore, 2014).

The pilot survey was made up of two parts: the ALERT Scale of Cognitive Style, followed by 18 questions. These, along with a summary of the pilot results, are included as Appendix A.

Participants in the pilot were students in an undergraduate course, SLIS 201, in the School of Library and Information Science at the University of South Carolina. Of the

five respondents, one was a sophomore, two were juniors and two were seniors. They represented 3 ethnic groups: African American, Hispanic, and Caucasian. Four of the participants self-identified as female, one male. Two of the respondents were Accounting majors; two majored in Library and Information Science, and one in Psychology. When asked to identify their intended occupation, two participants chose business and financial operations. The three other occupations selected were: computer or mathematical, healthcare support, and office or administrative support.

Several survey questions addressed the students' backgrounds. Four of the pilot's participants attended public high schools, and one a private high school. High schools were located in four states: Maryland, New Jersey, New York, and South Carolina. With regard to the occupations pursued by the adults in the home where participants grew up, a broad range of responses was received. Occupations listed here included: management of professional occupations, management of business or financial operations, business operations specialist, community and social services, education, training, or library, health practitioners and technical operations, healthcare support, personal care supervisors, and transportation or material moving.

The next section of the survey included questions about experiences and activities in which the students have participated, as well as people who have influenced them. What follows is a summary of the responses to those items received from each of the five individuals in the pilot survey.

Influential people

All of the five respondents listed parents as being important influences in their development of career interests. Respondent Number One commented that her parents

provided steady encouragement: “They told me that I’m able to do anything I put my mind to as long as I keep in the right path…” She also listed school clubs as being influential, and this was the most frequently identified activity among all respondents. Respondent One also credited travel with influencing her interest in medicine. Her primary barrier comes in the form of teachers cautioning her to avoid setting her sights too high.

In addition to parents and teachers, Respondent Two included “other family” and “group leaders” as influential people. She included an extensive list of activities, and also cited travel as an influential environment, saying that it “opened my eyes to an interest in business.”

Respondent Three was the only participant who did not include teachers as a category of influential people. She listed parents and peers, and cited internships, church groups, and sports as being particularly influential activities in her career planning. She was also able to observe her parents’ experiences as they started a business of their own.

In addition to his parents and teachers, Respondent Four was influenced by people he has never met. “Game designers and online personalities have kindled my passion for programming and development,” he wrote. School clubs were valuable for helping him to develop his skills in team-building and problem-solving. “I enjoyed coming up with solutions to difficult problems in clubs and sports teams.” He also commented on the supportive atmosphere at home, which allowed him to “spend a lot of time analyzing media and practicing programming.”

Respondent Five also chose her home atmosphere as an influential environment, saying, "My friend lives with me in our apartment, so she tells me all sorts of neat things about information science." She also included "peers" as a category of people that were influential, and described the benefits of participation in school clubs as helping her to "…be more sociable, and open up about myself more."

On the ALERT Scale of Cognitive Style, respondents to the pilot survey all fell into one of two categories: Strong Left Hemisphere Orientation (1) or Moderate Left Hemisphere Orientation (4). This indicates a tendency toward an analytical approach to learning and problem-solving. There was no division apparent across gender, as the one male participant fell into the same category as three of the females.

Pilot participants took the survey online and completed the ALERT Scale during class time. The total time required was under 15 minutes and the students reported no problems in understanding questions or completing the tasks.

Following analysis of these results, the decision was made to add ALERT Scale questions directly to the survey, in order to simplify data collection, and to allow for connections to be made between ALERT Scale scores and both the survey data and subsequent interview results. The open-ended questions included in the pilot survey were eliminated following in the final survey, in order to simplify coding of a larger number of survey responses.

Based on lessons learned in the pilot, the survey was modified and streamlined. The resulting instrument includes 35 questions, including the 20 items that comprise the ALERT Scale. The survey questions, administered to 121 undergraduates in September 2016, are included as Appendix B.

Scale of Cognitive Style. As part of the online survey, participants completed the ALERT Scale of Cognitive Style. The scale consists of 20 pairs of statements. Respondents are asked to choose the statement that best applies to their own attitude toward the situations posed by the questions. Scores reveal where the participants fall on a spectrum of cognitive styles ranging from Strong Left Hemisphere Orientation (sometimes referred to as "logical" cognitive styles) to Strong Right Hemisphere Orientation (also called "intuitive" cognitive style).

While cognitive style can be a useful framework for understanding an individual's preferred approach to learning and problem-solving, the ALERT Scale does not provide an in depth exploration. Rather, it gives a relatively simple overview and introductory look at how that individual learns. This type of scale is not viewed with favor in the fields of Neuroscience and Psychiatry, where testing addresses complex connections between brain function and cognition. For practical reasons, it was not possible to include this sort of complex instrument in the current study.

There is evidence that an individual's cognitive style can influence their career path. Martin (1998) outlines several points that should be considered in relation to cognitive style, which can be paraphrased as follows:

- It is possible to observe and measure differences in cognitive styles
- A person's cognitive style can be detected by observing verbal and non-verbal communications.
- Specific cognitive styles are associated with certain careers, and often take on a good or bad connotation.

- A person or organization can become more creative and effective when the two styles are fused. (p. 2)

While the analytic, or "left brain" cognitive style is most often associated with STEM, Martin (1998) emphasizes that there are benefits to both:

> …when differences and similarities among cognitive styles in a group are recognized and taken into consideration, a type of synergy can be created. This synergy results when the group honors the efforts of each of its members to use his or her particular cognitive expertise in those stages of the problem-solving process where it is most appropriate. For example, systematics and intuitives might work together on the first phase of the problem-solving process (problem identification). Then the intuitives might use a divergent approach by expanding all of the problem possibilities in order to identify all potential problems. Subsequently, the systematics might employ a convergent approach, using the intuitives' list to identify realistic problems. Ultimately, the focus of the group's problem-solving activity would become more and more narrow and specific until a problem statement could be generated. (p. 9)

The results of the ALERT Scale were tied to the other survey data, as well as responses in follow-up interviews, and examined for patterns and relationships, in order to create a more detailed portrait of participants.

Follow-up Interviews

At the end of the online survey, all 121 participants were asked to take part in a follow-up interview. The requested contact information was provided by 49 survey participants and of those, eight ultimately completed a follow-up interview. The 49

potential participants were contacted initially by email, and this round of contact yielded 5 scheduled interviews. After the first round of interviews was complete, a second email was sent, resulting in 3 additional interviews. The survey instrument included a total of 35 questions and required an average of seven minutes and 42 seconds to complete. The follow-up interview aimed to elicit greater detail on experiences of the students, especially in relation to their responses on the survey. Interview questions were open-ended, and asked respondents to describe their personal experience relating to the three major topics covered in the survey: people, places, and activities that played a role, whether positive or negative, in their choice of major and career. The interview questions are included as Appendix C.

Using directed qualitative content analysis, interview data were coded to uncover major themes and important ideas. This method is an established approach to analyzing data. According to Hsieh (2005), its goal is "to validate or extend conceptually a theoretical framework or theory. Existing theory or research can help focus the research question…" and "provide predictions about variables of interest or about the relationships among variables, thus helping to determine the initial coding scheme or relationships between codes." (p. 1281) Since some possible variables influencing females' participation in STEM have been identified by the research discussed above, this approach was useful for initial coding, which looked for data relating to mentoring, Implicit Bias, instructional approaches, and attrition, or change in career path.

Multiple rounds of coding were conducted, beginning with descriptive coding, which enabled the identification of major categories of data (Saldaña, 2011). Using field notes and analytic memos to guide that development, coding proceeded into in vivo,

values, emotion, and versus coding, as recommended by Saldaña (2011). A consistent and exhaustive list of schema was developed, to help insure inter-coder reliability, which was established through review by a fellow researcher. From the themes that emerged, it was possible to identify concepts that help to describe experiences along the path to STEM careers that students find beneficial, as well as those seen as obstacles.

These data were synthesized with the survey data and the ALERT Scale categorizations to determine where connections could be found and whether the data are in any way contradictory. Comparisons were made, with particular attention to contrasts that emerge in responses of males and females, as well as any differences observable in responses from students majoring in STEM and those in other academic majors.

Additional exploration

In an effort to expand understanding of the factors that are important for success in STEM, particularly among females, an interview was also conducted with a distinguished computer scientist and researcher. The subject to of the interview was suggested by the supervisor of this study. This individual is a Senior Research Scientist and Director of User Research at the prestigious Online Computer Library Center (OCLC). She collaborates on international research projects relating to topics like data mining and information-seeking behavior. She shared her experiences through her responses to the following questions:

- What were some early influences, mentors, or experiences that you feel were significant in pursuit of your interest in a STEM-related profession?
- Based on your experience, what advice do you have for young women interested in working in STEM or technology-related jobs?

- Are there any resources or programs that you know of that you would recommend to women getting started in STEM fields?

These questions were generated with the intention of reflecting the contrasts and similarities that might arise between the viewpoint of an established professional and that of undergraduates just beginning to navigate the world of work. The interview was intended to provide additional insight into current conditions and challenges for women in STEM careers. The wealth of information gained from this interview made it clear that the career paths of established female professionals in STEM would be a fruitful topic for future study. The interview data were coded and are discussed in Chapter 5 in terms of topics for further research.

Limitations

The current study was limited in the sense that the sample size was small, both for the survey (121 respondents) and the follow-up interviews (eight respondents). This was primarily due to time constraints and to scheduling challenges inherent to working with undergraduate students. Another factor could be that there was no incentive offered for participation. Although 49 survey participants provided an email address for follow-up contact, only eight eventually scheduled and participated in the interview.

The study's results are not generalizable, but instead they suggest what variables are most important in influencing these particular students in their decisions regarding major and career choice. Since the sample consisted entirely of undergraduate university students, it is also limited to people with sufficient financial means to enroll at a university. The sample has a small geographical reach as well, and includes only undergraduate students at two mid-sized universities in the southeastern United States.

A limitation imposed by the use of the ALERT Scale became evident during the course of the study. The scale was selected in part because of its very accessible language and brevity, and the fact that it has been vetted in the field. However, there is considerable question in disciplines like Neuroscience and Psychiatry about the scale's usefulness. Experts in these areas who have weighed in on the topic suggest that the scale overly simplifies the very complex processes and factors at play. While it is generally agreed that there are indeed different styles of learning and problem-solving, the notion that one side of the brain or the other may be dominant is largely dismissed (Kozhevnikov, 2007).

In recent years, more complex and reliable tests have been developed that more accurately measure cognitive style. These often involve hands-on activities in a laboratory setting, and would not be practical for the current study. With this evidence in mind, little significance can be attributed to the ALERT scores recorded for participants.

Conclusion

By focusing specifically on the experiences deemed significant by undergraduate students, this study sheds light on their perspective. It concentrates on experiences and influences outside of the classroom that the students themselves see as either help or a hindrance to their pursuit of chosen topics and careers.

While the research clearly shows that barriers to women persist into higher education and the workplace, early experiences may change the expectations of students, including young girls intent upon a STEM career. Understanding which of these are most beneficial or detrimental to their ambitions can valuably inform instruction and other efforts. Used in conjunction with greater awareness of the unconscious biases held by

people off all ages and genders, this information may begin to change the landscape for women in STEM.

Given the impact of excellence in the STEM fields upon the prosperity and progress of the country, clearing barriers and providing encouragement to females in STEM serves everyone's interests.

Chapter 4 -Findings

This chapter describes the findings of this study, derived from the data provided by both the online survey, administered to 121 undergraduates, and by the follow-up interviews conducted with eight undergraduates. It begins by summarizing the survey results and providing information determined from descriptive statistics. Next it gives an overview of the interview results and then includes detailed accounts of individual interviews. The chapter concludes by considering these two sets of data together in order to create a fuller picture of the ideas expressed by participants and the themes that arose in their discussions.

Survey Findings

The online survey was conducted in September 2016 on the Qualtrics platform. A total of 121 complete responses were received, with participants drawn from undergraduate courses at the University of South Carolina and the University of North Carolina-Greensboro. While 125 students participated in the survey, four did not complete all questions, stopping at the end of the ALERT Scale section. Their data were not included in the analysis.

As discussed in Chapter 3, the ALERT Scale was included to aid in discovering more about the participant's approach to problem-solving. It provided a general idea about whether the respondent tends to be more logical and analytical or more holistic and subjective in their learning style. Without the additional demographic information

provided later in the survey, scores were not useful, since they could not be connected to things like gender or major field of study.

Participant characteristics. The survey participants included 72 students identifying as female, 48 as males, and one who preferred not to specify a gender. This provided a fairly balanced sample, with roughly 60% of respondents being female and 40% male. The one "prefer not to answer" response was excluded in looking at data related to gender.

All of the respondents were undergraduates, and each of the classifications, from freshman to senior, were represented. Well over half of the students were freshmen.

The ages of the students surveyed ranged from 18 to 45, with 90% of respondents falling into the 18 to 21-year-old range. Asked to identify their race, four of the respondents selected "other", and the majority (57%) chose "white/Caucasian." Characteristics are summarized in Figure 4.1.

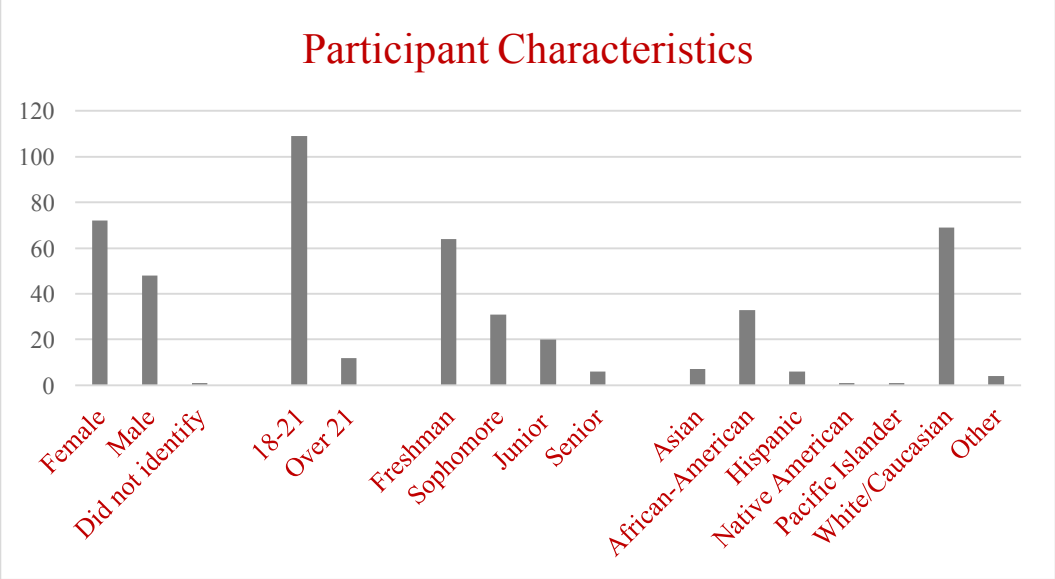


Figure 4.1. Characteristics of survey participants

ALERT Score. Among the 121 survey respondents, the average of the scores recorded for the ALERT scale was 8.33, and fell within the range indicating a moderate orientation toward a more analytical thinking style. There were slight differences in the averages when they were examined through the filter of gender or major field of study. These are illustrated in Figure 4.2. Since lower scores indicate a stronger tendency toward objective, logical, and analytical thinking, these results would indicate that the males in the sample group had a slightly greater tendency toward analytic thinking, and that STEM majors, whatever their gender, fell farther toward that end of the spectrum than did students with non-STEM majors.

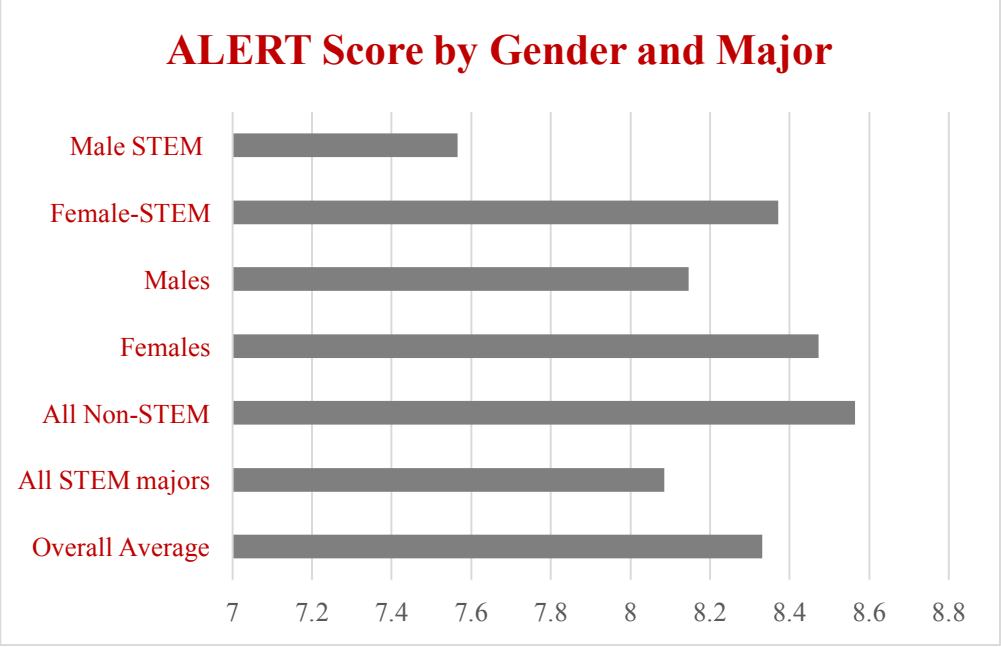


Figure 4.2. Scores on ALERT scale, by gender and major

While these data may prompt some interesting questions and inspire future investigations, ANOVA analysis indicated that the variables of gender and major (STEM or Non-STEM) are not strongly related to ALERT score, as shown in Figure 4.3.

Levene's Test of Equality of Error Variances[a]

Dependent Variable: Score

F	df1	df2	Sig.
	Independent: Gender		
2.280	1	120	.134
	Independent: Major		
1.373	1	119	.244

Tests of Between-Subjects Effects

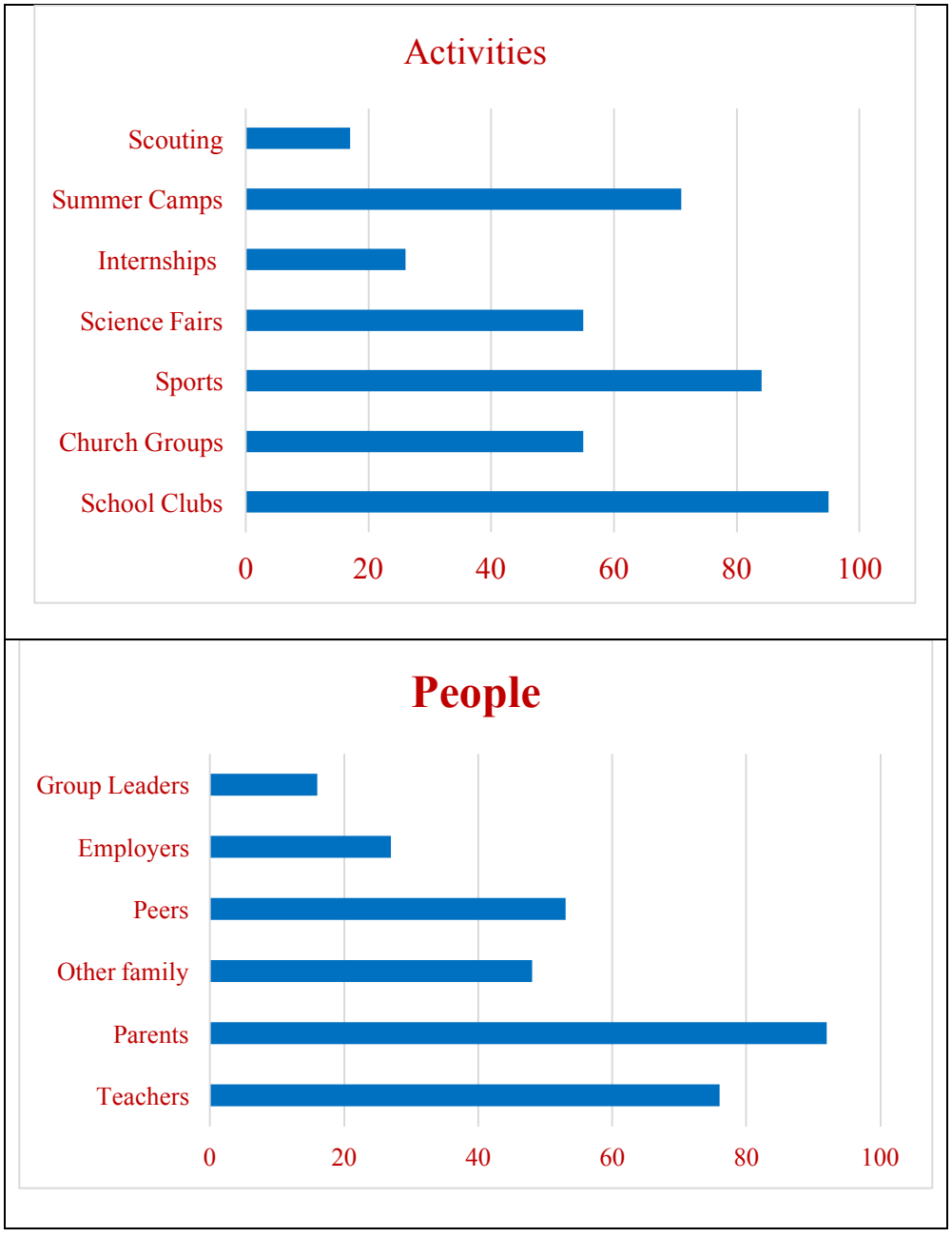
Dependent Variable: Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
	Independent: Gender				
Corrected Model	1.912[a]	1	1.912	.148	.701
Intercept	234.863	1	234.863	18.221	.000
filter_$	1.912	1	1.912	.148	.701
	Independent: Major				
Corrected Model	6.959[a]	1	6.959	.548	.460
Intercept	8380.083	1	8380.083	660.497	.000
Majors	6.959	1	6.959	.548	.460

Figure 4.3. Significance of variable relationships

Influences. In addition to the ALERT Scale and questions related to demographics, the survey asked participants to identify activities, people, and environments that were influential to them in choosing a career path. Another question

asked the students to identify barriers that they have faced. Figure 4.4 shows which options were chosen most often on these questions overall.



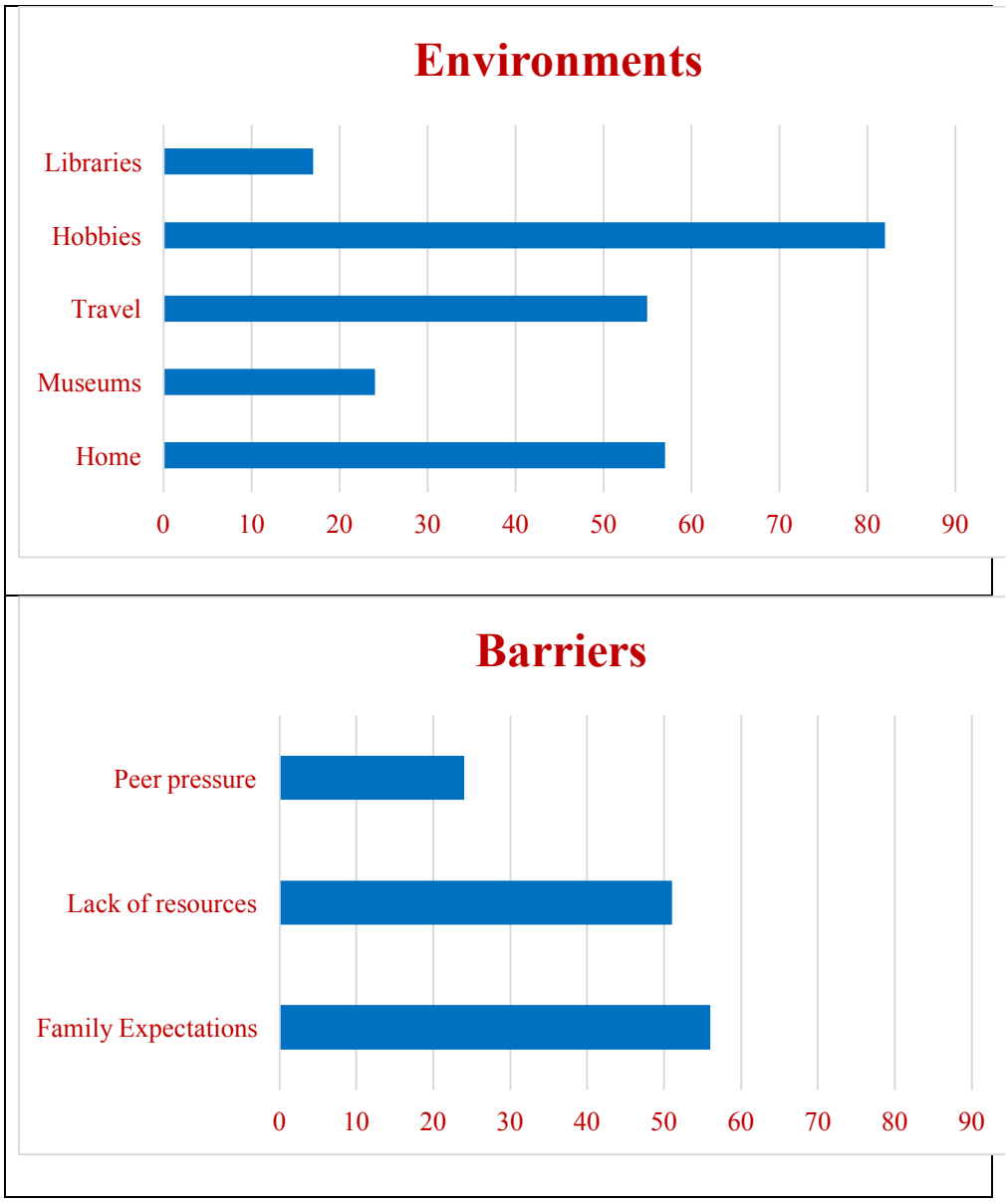
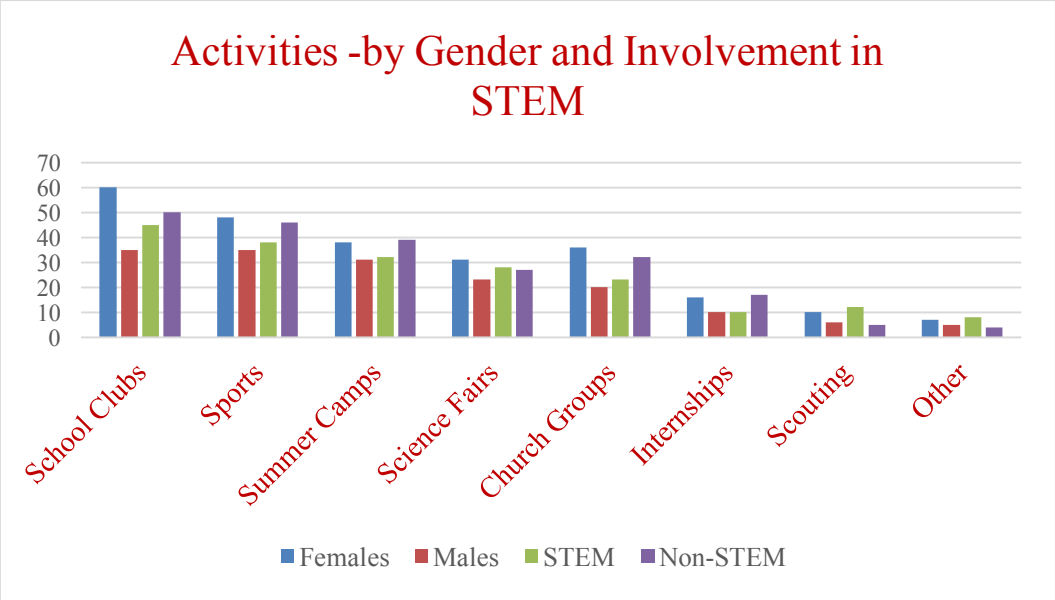


Figure 4.4. Selection of influences by survey participants.

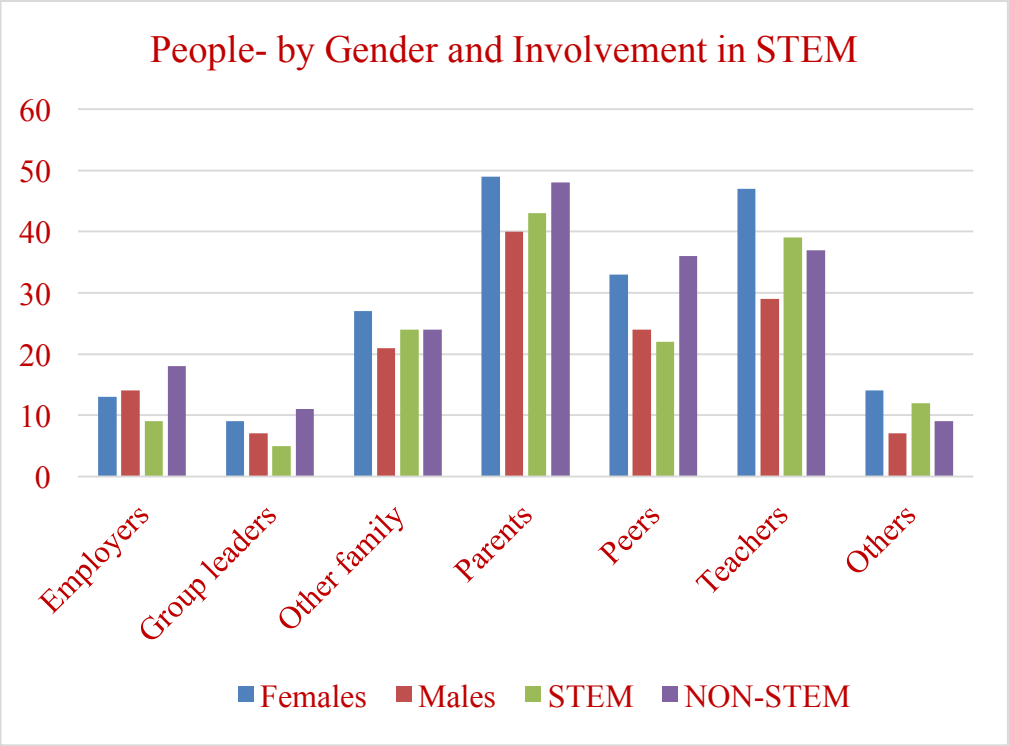
For further information, these responses were examined through various demographic filters. One that seems most relevant in the present study is gender, and another is whether the major field of study is a STEM or Non-STEM subject. The following set of figures breaks down the responses to questions about influential activities, people, and environments, as well as perceived barriers, based on those

characteristics. For each question, several participants selected "other," and supplied further information. Tables are included below to indicate what was entered for each of the four areas, with the items categorized by gender and by major field.



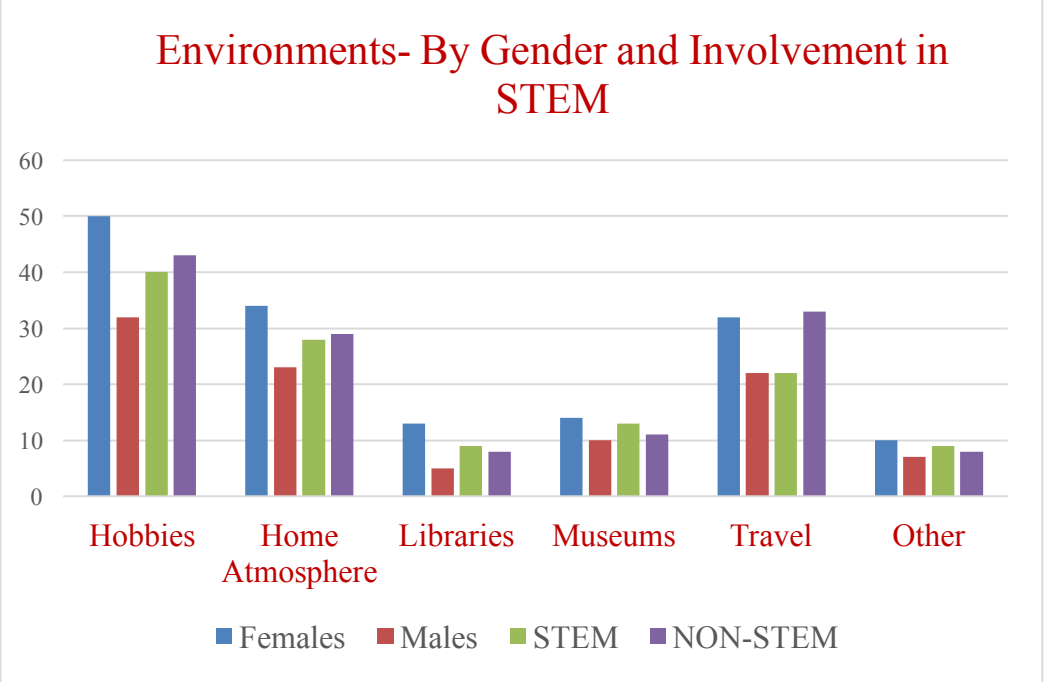
ACTIVITIES				
"Other" Responses	Females	Males	STEM	Non-STEM
Volunteering in Summer	X		X	
Military		X	X	
Job		X		X
Theater		X	X	
Marching band	X	X	X	X
Hospital/Daycare		X	X	
Performing arts	X		X	
Self Employed Job	X		X	
Teen Advisory Group	X		X	

Figure 4.5 Activities chosen, according to gender and major



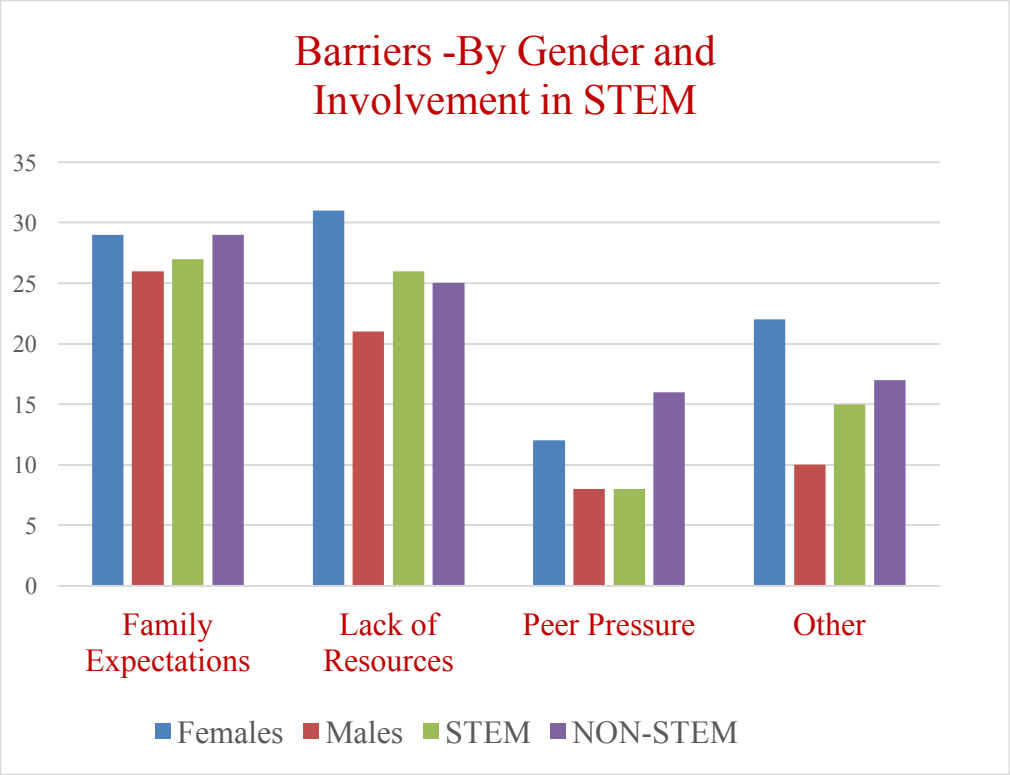
PEOPLE				
"Other" Responses	Females	Males	STEM	Non-STEM
Media	X		X	
School Programs	X			X
Mentor	X		X	
Celebrities	X		X	X
No one	X	X		
Myself	X	X	X	X
Children	X		X	X
Librarians	X		X	

Figure 4.6. People chosen, according to gender and major



ENVIRONMENTS				
"Other" Responses	Females	Males	STEM	Non-STEM
Research	X			X
School	X	X	X	
Hospital	X			
Church	X		X	X
Clinic	X			X
Internet	X		X	
Studio	X			
Work		X		X
Family History		X		X
Hospitals/Daycare		X	X	X

Figure 4.7. Environments chosen, according to gender and major



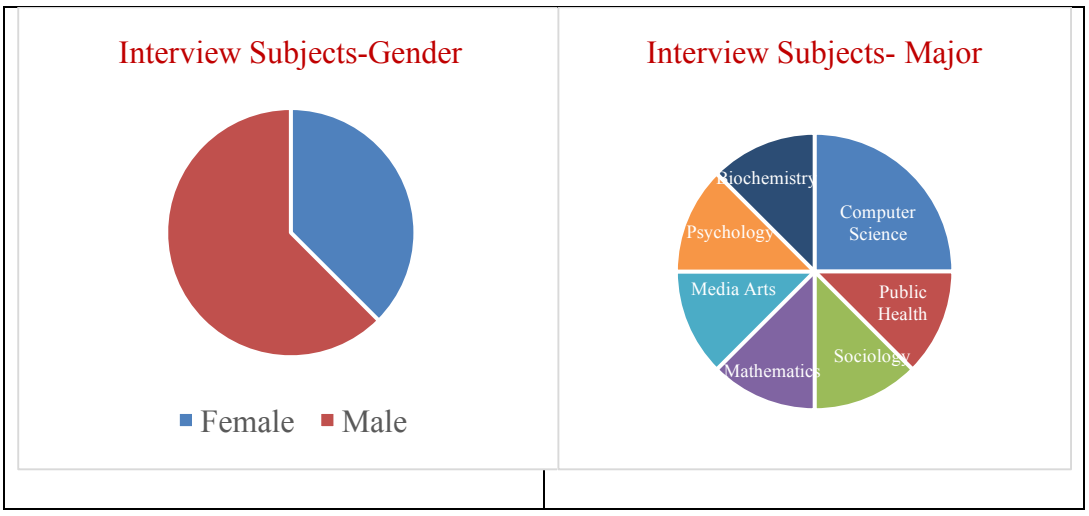
BARRIERS				
"Other" Responses	Females	Males	STEM	Non-STEM
Personal Expectations	X		X	
Self-Doubt	X		X	X
Grades	X			X
Indecision	X			X
Pay And Conditions	X			X
Prospects For Success	X			X
Financial Hardships	X		X	
Challenging Coursework	X		X	
Amount Of Work		X		X
Lack Of Direction		X		X
Lack Of Training		X	X	
Learning Challenges (ADHD)		X		X

Figure 4.8. Barriers chosen, according to gender and major

Interview Findings

This section describes the eight students who agreed to participate in a follow-up interview. It summarizes their demographic characteristics, identifies the major themes that emerged in the coding process, and then provides a narrative profile of each interview subject.

At the end of the online survey was a request for participation in a follow-up interview. Contact information was provided by 49 survey participants and of those, eight ultimately completed a follow-up interview. Five of the eight subjects identified as male, and three as female. Two of the male subjects were Computer Science majors. Other majors included Biochemistry (female), Psychology (female), Media Arts (male), Mathematics (male), Sociology (male), and Public Health (female). Among the respondents, 4 indicated their ethnicity as white, and 3 as African-American. One participant listed ethnicity as "other." Figure 4.9 provides an overview of this interview group, and is followed by a summary of their responses.



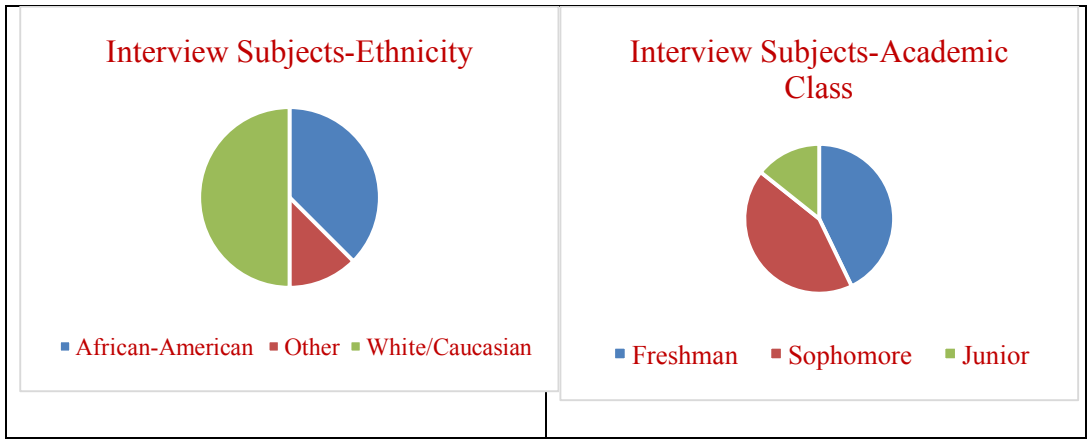


Figure 4.9. Summary of interview participants

Interview Responses. Coding of the responses collected in the interview process revealed several themes that could be used as a framework for exploring significant experiences in students' lives. These are ideas that were frequently mentioned as having an impact on each student's navigation of the path to a career and pursuing their interests. The themes are: a sense of belonging, a desire to help others, certain pivotal life events, the importance of a role model or mentor, the idea of self-directed learning, student's perceived level of control, and access to practical information and experiences. Figure 4.10 provides a summary of how frequently each of these ideas was touched upon in the interviews.

Descriptive coding was used simultaneously with in vivo, emotion, and versus approaches to analyze the interview responses. Each interview was coded in its entirety before moving on to the next subject, in order to provide a holistic understanding of each participant's experiences. With the same aim, interview data are presented in a narrative form in this report.

Interview Summary by Topic and Category									
	Interviewees								
Topics and Categories	A	B	C	D	E	F	G	H	Total
SENSE OF BELONGING									**9**
1A Peer connections		X	X		X				3
1B School connections							X		1
1C Family connections		X							1
1D Like-minded people	X		X			X	X		4
DESIRE TO HELP OTHERS									**6**
2A Volunteering	X							X	2
2B Each one Reach one		X			X				2
2C Sharing chosen field		X				X			2
PIVOTAL EVENTS									**8**
3A Health issues	X								1
3B Parent divorce					X				1
3C Adoption		X							1
3D Met inspiring person		X			X	X			3
3E Changing schools							X		1
3F Witnessed birth of sibling								X	1
ROLE MODEL/MENTOR									**9**
4A Validation of interest	X						X		2
4B Family	X		X	X	X	X			5
4C Lack of			X		X				2
SELF-DIRECTED LEARNING									**8**
5A Self-expression		X							1
5B Observe others		X				X			2
5C Pursue interests independently	X			X	X	X		X	5
SENSE OF CONTROL									**7**
6A Opportunities for leadership	X		X	X					3
6B Broad knowledge of potential occupations	X	X		X					3
6C Self-efficacy	X								1
NEED FOR PRACTICAL INFORMATION/EXPERIENCE									**6**
7A Exposure to the workplace	X								1
7B Teach kids how to think						X		X	2
7C Information on higher education	X	X						X	3
BARRIERS									**14**
8A Lack of resources			X		X				2
8B Discrimination		X	X		X	X	X	X	6
8C Learning problems	X					X			2
8D Negative comments		X	X			X	X	X	5
ENCOURAGING EXPERIENCES									
9A Environments									**14**

9A1 Travel					X	X		X	3
9A2 Work	X			X				X	3
9A3 Museums					X		X	X	3
9A4 Libraries							X		1
9A5 Church			X					X	2
9A6 Home			X	X					2
9B People									**10**
9B1 Family	X		X	X	X	X		X	6
9B2 Teacher		X	X						2
9B3 Peer							X		1
9B4Professional	X								1
9C Activities									**12**
9C1 Scouting					X			X	2
9C2 Science Fairs	X								1
9C3 Summer Camp		X				X			2
9C4 Sports			X					X	2
9C5 Theater		X							1
School Clubs		X		X	X	X			4
Total Responses	17	16	13	8	14	13	9	14	104

Figure 4.10. Coding Summary

Subject Profiles. To provide a more complete picture of each interview subject, the following section presents individual profiles. Subjects were assigned a pseudonym for purposes of identification.

Anna

Anna is a freshman attending the University of North Carolina at Greensboro. She is studying Public Health, and is intent upon a career in medicine. Anna attended a public high school in North Carolina, and took advantage of several opportunities outside of the classroom for exploring potential careers.

The ALERT scale score for Anna was 8, which indicates a nearly neutral orientation, slightly favoring the analytical. In her interview, Anna described her approach to grocery shopping. Her strategy is geared toward efficiency, proceeding from an inventory of the refrigerator through generation of a categorized list that makes it possible to move through the store systematically, and "not go back and forth."

In her interview, Anna indicated an inclination toward science and math, along with an interest in working with children. She is looking for a career that will allow her to balance these interests with her desire to be a mother, and although she did not list that as a barrier to pursuing her chosen field, she did mention it when asked about biases she has encountered. She expressed concern about the time it would take to complete a medical degree, saying "I don't want to be 30 when I have kids."

What follows is a discussion of Anna's interview responses, aligned with the major themes revealed in the coding process.

Sense of belonging. While Anna made less explicit reference to the importance of feeling like she fits in or belongs, she did express a feeling of comfort and ease in specific environments. For example, she was very comfortable with spending time in a hospital, working with children with disabilities, assisting in a classroom, and volunteering with children and families. In discussing these situations, she mentioned that, in addition to enjoying her activities, they also helped her to feel competent and able. This suggest the idea that a major factor in creating a sense of belonging may be our feelings of competence and self-efficacy.

Desire to help others. Anna currently volunteers at the Ronald McDonald House in her town, as part of her sorority's philanthropic effort. She described her enjoyment of this activity, saying "that is the kind of environment I want to be in." She also taught Sunday school, and enjoys any environment in which she can work with children.

Pivotal events. Anna mentioned two life events that had an impact on her career interests. The first occurred when she was very young (7 years old). Her grandfather was diagnosed with cancer and the family spent a lot of time at the hospital. This was not a

negative experience for Anna, in the sense that hospitals did not make her uncomfortable. "I have always been fine with them (hospitals). …I would pretend to be a doctor."

Another significant event occurred when Anna was 18 years old. She had been a competitive swimmer since age 5, and stopped swimming when she went to college. This sudden change in her level of physical activity caused her to have problems with weight gain (50 pounds in 2 months) and metabolism issues. Interacting with her team of doctors encouraged her interest in nutrition and medicine. "… all of that was really interesting to me and made me want to learn more."

Role model/mentor. A significant role model for Anna was her mother, who was a 3rd grade teacher. In high school Anna often visited her mother's class to work with students there: - "She took me to work with her when I was in high school and I loved working with the kids. I would read to them and help them. That helped me see that I am good at working with kids and to decide that I want to do that in my career."

Self-directed learning. While dealing with her health issues, Anna took it upon herself to learn more about topics like nutrition and how the metabolism works. Her doctors recommended books and documentaries, which she purchased. --"I started doing a lot of reading about it on my own…"

Control over situations. Closely related to the idea of self-efficacy, the degree of control and choice that people have over their situation and activities can be an important factor. For Anna, this came up in her discussion of experiences she had that gave her exposure to the workplace. She mentioned visiting her mother's classroom, working as an intern in a veterinarian's office, and shadowing her father at his office.

While the classroom experience was very positive, and helped her to feel competent in working with children, Anna did not feel the same connection in her father's business setting or at the veterinarian's office. Those experiences led her to conclude that she would not be well suited for either of those work environments, and she had enough control over these situations to steer future workplace experiences in a more desirable direction.

Need for practical information and experiences. Anna was aware that she had many valuable opportunities to explore her interests growing up, including internships, summer jobs, and volunteer work. She did express the wish that she had been more aware of specific jobs that full under the umbrella of medicine, aside from "doctor" or "nurse." Without that information, she felt that her career choice has involved a lot of "trial and error." "I would have liked to have programs in high school that help you explore careers and get an idea of what's out there," she said.

In both the survey and the follow-up interview, Anna was asked to comment on which activities, environments, and people encouraged her to pursue her chosen career field and which acted as barriers.

Barriers. In the survey, "family expectations" was selected as a barrier faced by Anna in choosing a career. This is clarified in the interview when she described her childhood experience of having a stay at home mother. It is reflected in her conflicted feelings about balancing work and family, describing the importance of being a mother and the need to take that into consideration when planning a career.

In her interview, Anna also mentioned that she has "severe" ADHD. This came up in her description of her experience shadowing her father at his workplace. At that

time, she decided that the office environment was not for her. Due to her condition, she said, "I know I need to keep moving.

Pathways. Anna listed several experiences that encouraged her interest in math and science. She participated in science fairs, summer camps, and internships that helped to shape her goals and clarify her strengths. These were all seen as positive influences, even when they served mostly to show Anna what sort of work she did *not* want to do. Parents and teachers were also influential, as were libraries, travel, hobbies, and home atmosphere.

Ben

Ben is a male student at the University of North Carolina Greensboro, majoring in Mathematics. He graduated from a public magnet school in North Carolina.

The ALERT score for Ben was 5, which indicates an inclination for taking an analytic approach to learning and problem solving. This score is closer to that end of the spectrum than that of most survey respondents. The average score overall was 8.4. In his interview, Ben described his process for paying monthly bills. His strategy is to pay his bills early to ensure that he avoids making a late payment.

Sense of belonging. This category was especially significant in the responses from Ben. He described feeling like an outsider in nearly every situation he encountered growing up. He attributes this in great part to the fact that he was given up for adoption as an infant and was not actually adopted until age 7. This made it difficult for Ben to establish relationships in many settings.

> …in school I always complained about not having friends, or I didn't really like the way that the teachers…treated me. Also, when people would share things

about themselves I wouldn't be able to say anything because I don't really know my parents.

Despite these challenges, Ben formed positive relationships with certain teachers at school, which helped him to feel wanted there. This, in turn, had a positive impact on his attendance and performance:"…because she cared. I felt at home. I felt like I was wanted there, so then I was never late again, and I was always present to class."

Desire to help others. While Ben expressed some alienation in his relationships with peers in high school, he also described a desire to help others to succeed. He mentioned that he tutored several friends in math, helping one in particular to pass a final exam despite missing three weeks of class due to illness. "I like seeing the success of other people. Whatever field I go into, I want to help other people be successful," he said.

Pivotal events. Ben's family situation had a profound effect on his development of his own identity, as well as feelings about belonging, which in turn influenced his level of involvement in various activities. He repeatedly referred to the fact that he was given up for adoption, and then did not find a family for several years. This colored his outlook on how others perceived him and he saw subsequent events as validation of his ideas about not being wanted.

One example of this was his experience with a neighbor during childhood. This was a retired math teacher, and Ben spent time with her regularly, getting help with math assignments. He described his disappointment when the neighbor moved away, saying "…every time someone important comes in my life they end up leaving."

Role models/mentors. While his experience with the math teacher next door was a source of sadness for Ben, it was also his first experience with a mentor. He mentioned the fact that his math teachers have been a source of inspiration. They reinforced his feelings of self-efficacy in math, but also encouraged a sense of belonging in the school environment. This aspect of the relationship seems to hold the most value for Ben, who felt valued by the teachers:

> I don't know if I really liked them because we were doing the same fields, but I noticed that they were the ones that were able to inspire me the most, and they were the only people in my life that I felt cared about me.

Control over situations. While Ben had little control over his family situation, he was able to exercise control over his academic pursuits. His family background left him struggling with his identity, he found ways to build that through his studies.

Ben indicated that one reason for his interest in mathematics is its "stable" and "exact" nature. He found that math helped him to feel an increased level of stability and control. His other interest, theater, has given him a chance to explore his identity through his portrayal of a wide variety of characters. He noted that theater "gives me a little bit more freedom," and appreciates the balance between the structure of mathematics and the ability to live vicariously through his character which is afforded by theater.

Need for practical information and experiences. In discussing programs or information that would have been useful to him in deciding on his college major and occupation, Ben again referred to the fact that he did not have access to advice from his parents. He would have liked to know what careers his biological parents had, believing that he might have some genetic predisposition to similar careers.

Ben also expressed the idea that high school did little to prepare him to navigate in college. He would have liked more information on the workload involved in various majors. He is currently pursuing a double major in mathematics and theater, but feels that if he'd had a more realistic idea of the work involved he would have likely chosen one or the other.

Barriers. Ben's main barrier has been his struggle with identity and belonging, which he attributed to the lack of a stable family and home in his early years. Even now, he does not feel a close relationship with his adoptive mother, who he said "makes these really rude comments." He described his appreciation of being able to confide in a teacher about this relationship, saying that the teacher "would always keep up" with what was going on there.

In terms of barriers related to his choice of major, Ben mentioned that "a lot of people hate math." This has caused him to doubt his choice of mathematics as a major and to feel discouraged about his career path. He has also encountered negative comments from peers with regard to theater: "There's always bad vibes there. …you're not going to make much or you're going to end up being a waiter, living in the ghetto of New York… and barely making it."

Pathways. Experiences and situations that were encouraging for Ben often involved making personal connections. His background has created a feeling of distance and alienation, but feeling wanted and accepted at school alleviated that and made participation and achievement possible. Encounters with a caring adult were mentioned repeatedly as positive influences.

Ben participated in summer camps at a local performing arts center, which helped him to gain confidence in his theater skills. This was the only helpful activity listed by Ben in his survey responses, and school was listed as an encouraging environment.

Carl

A male, African-American junior at the University of South Carolina, Carl has a major in Media Arts. He attended a public high school in South Carolina, and credits his home environment with encouraging his interest in video games and film-making.

On the ALERT scale, Carl had a score of 10. This is higher than the survey average, and indicates a "bilateral hemisphere balance" –in other words, a cognitive style that utilizes both analytic and more holistic approaches to learning and problem-solving. In the interview, Carl described his approach to grocery shopping. He makes a list, prioritizing "must-have" items and then leaving room for additional items that he might also like to have. Before shopping, he checks his bank balance, and at the store he keeps a running tally of his spending in order to avoid exceeding his target amount for the shopping trip.

Sense of belonging. In discussing the types of environments that he finds encouraging, Carl made the point that the people he interacts with are what make an environment positive: "…it may not be necessarily a great environment, but just …having genuine people in that environment can alter it to be a more positive one."

Participating in high school sports was also important in helping Carl to feel like a part of things at school. He credits membership on basketball and cross-country teams with contributing this, as well as teaching him the value of discipline, humility, and hard work.

Role models/mentors. Carl did not feel that he had access to professional mentors, since he grew up in a small town. His career interests are related to hip-hop and film making, industries that had no presence there. He commented on the lack of professional mentors in that environment: "It's not like I could job shadow a director or anything, coming from where I've lived."

Carl did indicate an appreciation for the value of peer mentors and support from others. He stated that the "people I surround myself with now" were supportive and that he would frequently brainstorm with them about the next career move.

Self-directed learning. Carl mentioned the value of interacting with people who come from diverse backgrounds in helping him to develop his understanding of different human experiences.

Control over situations. Carl expressed positive feelings about his ability to influence his environment and direct his own course. He said he realized that he had a huge impact on his own environment. His experiences, including serving as a team captain and as a camp counselor, provided numerous opportunities for developing leadership skills, which he has been able to apply in his academic work as well.

Barriers. The primary barrier cited by Carl was a lack of resources. Despite qualifying for the Governor's School for Arts and Sciences in his junior year of high school, he was unable to participate. This was due to his inability to produce a 3D sculpture, which was a part of the application process. Not having access to the necessary equipment, or to funds for securing it, led to a missed opportunity.

The lack of access to equipment was a significant barrier for Carl, since film making involves the use of a range of camera lenses, lights and other expensive items. He

also cited a lack of resources as limiting his choices in terms of college, saying that attending a school in another state was out of the question due to financial limitations.

Another factor that Carl saw as a barrier to his pursuit of his career interests was related to the attitudes he perceived in the people around him. He referred to this as peer pressure, and said that his progress was inhibited by a feeling that no one had high expectations for him. While he was encouraged to participate in basketball, he did not feel similar encouragement with regard to other interests, particularly academic.

Carl also perceived some bias with regard to whether African-Americans have a place in film making. He felt discouragement from his peers in particular, saying that they told him he was "in over your head…definitely (behind) a façade or mirage or fake world I'm living in."

Pathways. In terms of activities, people, and environments that helped Carl move forward along his chosen path, there was an emphasis on experiences outside school. He participated in church groups and played the piano in church, both of which contributed to the development of his interest in music.

The home environment was also mentioned as being encouraging, particularly with regard to his interest in film making. He cited the ready availability of movies and video games in the home as important in developing that interest. At some point, he said, he realized that he could make those himself.

Carl has held a number of jobs, and they had an impact on his development. His job as a summer camp counselor helped him to develop interpersonal and communication skills, and was an opportunity to interact with people of different ages and backgrounds.

Participating in sports was seen as encouraging, in the sense that it helped Carl to develop self-discipline and leadership skills.

People who were helpful to Carl in pursuing his interest included his parents. His father, who was in the military, provided structure and an example of how to present oneself professionally, while his mother helped him to learn to be a "people person."

Dan

This interview subject is a white male, majoring in Computer Science at the University of North Carolina at Greensboro. He is a freshman, and attended a public high school in North Carolina.

The ALERT score for Dan was a 4. This shows a strong preference for taking an analytical approach to problem solving. This cognitive style seeks to identify causation and objectively analyzes information. Dan chose to describe his process for paying his monthly bills in answer to the first interview question.

To tackle the monthly task of paying his bills, Dan uses a Google spreadsheet to track and calculate expenses. He predicts his income for the month, and then prioritizes payments if necessary. Generally, he has enough money to cover all of his bills, and he reserves a certain amount for unexpected expenses.

Pivotal events. Dan graduated from high school one semester early and joined the National Guard. This was an important event with regard to his pursuit of career interests. In the National Guard, he works as an information technology specialist. This has enabled him to earn several key certifications and to find other jobs at places like Best Buy and the local cable provider.

Role models/mentors. Dan cited his older brother as an important mentor. He was in the National Guard, also working as an IT specialist, and helped Dan to make the connections necessary to secure a similar position.

His brother also exposed Dan to computers throughout his childhood, primarily through "playing World of Warcraft probably eight hours a day."

Self-directed learning. Building upon the interest piqued by his older brother, Dan went on to explore computers on his own, at home. He began to design websites at age 14, and built a computer at age 15. Through his tinkering at home, he was able to teach himself about how they work. He asserted that "self-teaching is a very good thing."

Control over situations. In discussing his approach to planning his career, Dan mentioned that he had practical reasons for choosing information technology: "I like to think realistically and how things will affect me in the long run. …that's why I chose IT, so I could work right away and not be in school for six to eight years…"
This demonstrates his positive sense of self-efficacy with regard to choosing the career path that works best for him.

Barriers. Dan reported encountering very few barriers to his pursuit of a career in computer science. He did not recall hearing any discouraging comments, saying that this was "because that was such a good field to be in."

His mother was a police officer, and this fact came to light in the discussion of whether Dan has encountered biases along the way that had an affect on his pursuit of his interests. He cited his mother's occupation as an indication that gender bias is not an important factor in career choice. "I feel like there's really no barriers to what really anyone can be. Really I just don't see it."

Aside from expressing regret that he did not participate in high school sports, Dan did not name any helpful experiences or resources that he felt were unavailable to him. He did feel that sports would have been beneficial to him personally, since it might have helped him to develop more skills in working with a group. He tends to "work much better independently."

Pathways. The work and home environments were most important in helping Dan to pursue his chosen field of Computer Science. His first work experience was an internship through his high school, with the IT department, which helped further his understanding of computers and networks.

Following high school, Dan received 5 months of IT training through the National Guard. He indicated that the training, along with the work experience in systems management, was extremely helpful to him in pursuing his interest.

His family and home environment were also encouraging to Dan, who cited both his brother and mother as positive influences. They both took an interest in his plans and helped him to make progress. The fact that his older brother was home-schooled meant that he was always there and spent a lot of time on the computer, which in turn increased Dan's exposure to them and his ability to explore his interests.

Ethan

This interview subject is an African-American male who attends the University of North Carolina at Greensboro as a sophomore majoring in sociology. He attended a public high school in North Carolina.

Ethan had an ALERT scale of 14, which suggests a moderate orientation toward more holistic, intuitive, and flexible approaches to learning and problem-solving. For the

first interview question, he chose to describe his approach to grocery shopping. He checks the inventory at home and creates a list built around a menu, selecting items for particular dishes he plans to make. Once at the store, he starts at the back and proceeds to the front of the store. He noted that he often digresses from his list, saying, "I kind of get sidetracked sometimes. I find myself getting something that I don't necessarily need."

Sense of belonging. In terms of his feelings of belonging in various settings, Ethan expressed a great interest in the people around him. He felt comfortable with his peers and described "studying people:" observing their behavior and reflecting on the effects of their actions. He recognized the value of networking and made note of the talents and behaviors that made someone a valuable contact. He considered himself to be an independent person in high school, but he also mentioned his ability to make connections with a wide range of people.

Desire to help others. In describing difficulties he faced growing up, Ethan made mention several times of the fact that he wanted to help others "coming after me." He believes that this desire to help others has always been a part of his make-up, and that it was recognized and encouraged by his mother. He took advantage of opportunities to become involved in community service projects, and said that he looked for ways to develop skills that would make him an asset to others. "My mom actually saw at a young age that I wanted to help people in any way I could."

Pivotal events. Ethan mentioned two events that had a significant impact upon his development of career interests. His parents divorced when he was in elementary school, and Ethan saw this as having a very negative effect upon the family's finances. He saw that his mother was working very hard to supply his needs and those of his older

sister, and suggested that this may have led him to be more independent. He expressed a reluctance to ask for any "extras" in order to avoid becoming a burden to his mother.

Another important event for Ethan was meeting a friend in 6th grade who came from a more disadvantaged background. This peer overcame challenges relating to poverty and seemed to only become more determined when difficulties arose. Ethan said that meeting her changed his perspective about his own situation and created in him a desire to help as many people as he could to overcome similar circumstances.

Role models/mentors. In discussing influential people in his life, Ethan said he would have liked to have a professional mentor when growing up. Although proud of what he was able to achieve, Ethan expressed the idea that it would have been easier with a "trailblazer" –someone who had gone before and could help guide him.

Barriers. Growing up in a single-parent household resulted in a lack of resources which Ethan felt posed a barrier to his pursuit of his career interests. He mentioned the fact he would have liked to participate in sports, but he was unable to afford to do so. As discussed above, Ethan was reluctant to ask for things that he saw as extras, given the tight financial situation faced by his mother.

Ethan also discussed both racial and gender bias in describing barriers that he faced. As an African-American, he found it to be true that he had to work much harder than some of his peers in order to succeed. He described talks with his mother on the subject, recalling: "…she was saying, 'you work twice as hard; you have to. You have to work twice as hard just because of the world we live in, and if you hate it so much, then fix it.'"

Ethan also felt that his gender affected his ability to pursue his career, although in a more positive way. The majority in his field, he said, are female. He expressed the belief that this could be an advantage, since there are fewer males in the profession. He did not like the idea of being able to move ahead purely by virtue of the fact that he is male. When people in field suggested to him that he would be able to rise through the ranks quickly as a man, he said that "being put at the top felt so uncomfortable, just because it was unfair to everyone else. I want to be judged by my brain capacity, not so much as who or what I am."

Pathways. Ethan described several experiences and situations that he felt were beneficial to his pursuit of his chosen field. The areas that he mentioned here included travel, museums, school clubs, and scouting.

As a child, Ethan was able to travel outside the U.S. with his mother, and credits these journeys with expanding his views regarding the range of human experience and just what actually constitutes "the norm."

> Just to go see how other people live and how they see the world is kind of like… it opens your eyes to a new perspective that you didn't have before. Communities (in S. America) have more of a "we" thinking vs. "I" thinking. I like that a lot, because they don't feel…isolated, I guess, or in competition. Everyone's trying to pull everyone up together, trying to better their environment all together.

In describing his reaction to museum visits, Ethan expressed the idea that art allows us to tap into the experience and perspective of the artist:

> … a good artist will always put a piece of themselves into their work, so you're seeing them at a different or deeper level, and therefore you get to see their view

of the world. Every time you see a new piece of the world that you weren't able to get before.

This comment echoes Ethan's habit of observing the people around him to formulate ideas about their motivations and the effects of their actions.

Ethan named his mother as the person who was most influential to him, encouraging him to pursue his interests. He described having long conversations with her about things that he was learning in school. She encouraged him to participate in scouting, and explained to him that in order to help others we must first develop skills that will make us useful and effective. Ethan credits her with instilling in him a sense of gratitude which in turn fosters a positive outlook.

The activities mentioned as having a positive impact on Ethan's career plans included Boy Scouts and school clubs, including the Future Business Leaders of America (FBLA). Scouting had great appeal due to its community service component, and Ethan felt that FBLA helped him to develop the skills he would need to better himself so that he would be in a position to help others in the community.

Frank

Frank is a white male freshman at the University of North Carolina at Greensboro. He majors in Computer Science and attended a private high school in North Carolina.

On the survey, Frank received an ALERT score of 11, which suggests a learning style that is balanced, sometimes called a bilateral orientation. On the first interview question he chose to describe his approach to deciding on a restaurant. His basic approach is to gather any information he can and then proceed, whether there is a definite plan in place or not. He begins by asking himself several questions: What am I in the

mood for? Do I want to go out, or stay in? If he plans to eat with a friend, he will ask whether they have a place in mind. Otherwise, he will "drive a little bit aimlessly in the direction of a restaurant or a couple of restaurants…"

Sense of belonging. Frank spoke a good deal about how encouraging it has been for him to spend time with like-minded people. He expressed the idea that being around peers who were interested in computers made it easier for him to pursue his own interests. He mentioned being involved in groups where an interest in computers was "normal" encouraged him to keep working in that area. Meeting people with the same career interests was an affirmation of his own choices.

Desire to help others. In discussing his ideas about helping other people, Frank expressed a desire to share his chosen field with others. This was motivated by his own positive experiences related to that field and working with computers: "Work with computers really, really changed my life for the better, so I want to help people learn about this."

Pivotal events. Frank mentioned a time when he was very young (six or seven) and met a technician from Best Buy who came to the house. After watching him work for some time, Frank began to ask questions. He found the experience very interesting, and found that he could "make sense out of some things." This was the beginning of his interest in computers and programming, since he was able to make connections for himself, and carry his interest forward.

Role models/mentors. In discussing what encouraged his interest in computers, Frank mentioned that his older cousin was an important role model. The cousin had computers and games, and Frank looked up to him. Spending time at the cousin's house,

and seeing his cousin's interest in computers and programming, helped to convince Frank that this was a viable field for him to pursue: "He was …into all the same things that I was. I thought he was the coolest thing in the world."

Frank encountered other role models among other "gamers" that he met growing up. These were people who were interested in the same careers that Frank was choosing for himself, and helped to direct his explorations.

Self-directed learning. Following his encounter with the Best Buy technician, Frank began to explore computers and programming independently. He moved beyond information provided by others. "I'd keep going a little bit deeper into it," he said.

Need for practical information and experiences

When asked about what resources he would have like to have growing up, Frank said that he felt he's had many good opportunities, mentioning in particular a programming class in middle school. Through his own initiative, he was able to expand upon the information provided there. However, he did feel that today's students should be given engaging information on how computers work at an earlier age. He said that in order to understand computers, most children needed to learn new approaches. "In a way, you relearn how to think," he said.

Barriers. When the discussion turned to barriers that Frank may have faced, he shared that he has been diagnosed with ADHD, has "some anxiety," and may fall somewhere along the Autism spectrum. He said that this was a bit of a barrier, at least when he was younger, but that he chooses to see his condition as an asset. He said, "I like to say I think like a computer." He is able to think very methodically, which he feels is helpful in his work with computers.

In response to the question asking about any biases he may have encountered, Frank mentioned gender bias. He recalled having technology classes in high school in which female students were given special attention. His school was part of an initiative to increase the number of female students participating in STEM, and while Frank felt that girls certainly belong and have talent in STEM, he did not view favorably the special treatment they received in his classes.

Another barrier mentioned by Frank was the fact that his parents did not recognize the value of his activities with relation to computers and programming, particularly in gaming. He found that participating in gaming enhanced his programming skills and understanding, but felt that his parents did not see the connection. He recalls that his parents often wanted him to "get off the games and spend time with the family." In terms of his interest in computers, comments from his parents were "a bit of a discouraging factor."

Pathways. As discussed above, Frank's older cousin was a role model who validated his interests in technology. This was the only family member mentioned as being helpful.

Frank mentioned two specific activities that he felt helped him to pursue his interests. He participated in a summer programming camp and also traveled to gaming tournaments around the country. He continues to compete in these events, and has found them to be very motivational.

Gayle

This subject is a sophomore at the University of South Carolina. She is a white female, majoring in Psychology. She attended a public high school in South Carolina.

Gayle scored 14 on the ALERT scale, reflecting a moderate orientation toward a more holistic, subjective approach to problem-solving and learning. On the first interview question, she chose to describe her process for grocery shopping. Her first task is to decide whether she really needs to go to the store or not. Once she decides to go, she will "inevitably" buy more items than she set out to. She generally goes shopping when she needs one item, without making a list. Once in the store, she will pick up other things that catch her eye. She did not seem completely satisfied with her process. She mentioned that she usually "chastises" herself for not making a list. She mentioned that her ideas about what to buy may change if she sees particular bargains at the store.

Sense of belonging. For Gayle, a sense of belonging came in the classroom. She has very positive feelings about herself as a student: … "I've always been smart. I've always been a good student." She stated that academics are her strength.

Pivotal events. Gayle attended a private religious school for much of her early education, but moved to a public high school She said that this had a profound effect upon her ability to explore her career interests. At the private school, she felt that she was not being told the truth; that many facts were being withheld from her, particularly in science. Upon entering the public school, she said, she "was able to take AP Biology and learn my way out of all that."

Role models/mentors. Gayle cited a peer as one of the people who most influenced her to expand her scope and explore a variety of subjects and career ideas. This "best friend" was the first person with whom Gayle could have "intellectual discussions", and these led her to look beyond the types of careers that her parents had suggested.

Self-directed learning. Gayle mentioned always having been a curious child, she liked environments that allowed her to pursue her interests independently. She felt especially stifled at her private school, where information was carefully rationed and certain subjects were not discussed.

Need for practical information and experiences. While she was generally able to find information on her own, Gayle did mention that she missed out on the opportunity to take college courses during high school. She would have liked to do that, she said, but "nobody ever told anybody in my school about that."

Barriers. The primary barrier that Gayle faced was related to religious bias. She felt that her education was handicapped by the limited access to scientific information provided by her private middle school: "…that robbed me of some opportunities to never have learned really, really false information and have learned some positive, helpful information. I wish that nobody ever had to go through that."

Gayle also reported hearing negative comments from her family with regard to her career interests, recalling her mother saying: "…you shouldn't pursue this career because you're not good enough." On the other hand, her family did expose her to several experiences that Gayle cites as encouraging her to pursue her interests, including providing access to places that encouraged independent exploration, like museums and libraries.

Pathways. Among the pathways that Gayle encountered, museums and libraries were very significant environments. "As a kid I particularly loved museums," she said. She felt that these environments welcomed the curious child, and and mentioned that "outside of those environments, it kind of seemed like my intelligence was not a good

thing." She felt that these place encouraged questions and exploration, and were very positive places for her.

Hannah

Hannah is an African-American female, studying Biochemistry at the University of North Carolina at Greensboro. She attended a public high school in North Carolina.

With an ALERT score of 10, Hannah would be categorized as bilateral, and might be expected to use a hybrid approach to learning and problem-solving. She chose to describe her process for choosing a restaurant on the first interview question. She starts with three criteria: proximity, price, and what type of food she is craving at the time. She also considers the advice of her peers, who can tell her about the prices and the quality of the food.

Desire to help others. Hannah mentioned her involvement in several community service projects, including volunteering for blood drives and bringing aid and supplies to the homeless. She said that these experiences helped her understand how to be a good citizen, and also provided her with information about "different types of career choices."

Pivotal events. Hannah intends to become an obstetrician, and she asserts that this idea was hatched when she was very young. She reported that, at age 3, she was present at the birth of her sister. This, along with accompanying her mother and sister to doctor visits over the years sparked her interest in becoming a "baby doctor."

Self-directed learning. Hannah mentioned that she enjoys being able to learn new things, and also that she considers herself "a different kind of learner." She indicated that she has a short attention span and likes to be able to redirect her attention when she is ready.

Control over situations. In discussing the people she encountered that had a negative influence upon her, Hannah described feeling helpless to change the situation. She described being unable to express what she was feeling "without seeming like a brat" when she felt uncomfortable with how an adult was treating her. She did not like being in the situation of having to spend time with these negative adults despite her preference to avoid it.

Need for practical information and experiences. Hannah felt that she would have benefitted from more information related to higher education and how best to prepare for college:"I wish that growing up I would have had more resources in learning about higher education –the basics of college are totally different from the basics in high school.…nobody really showed me how to study."

Barriers. The main barriers encountered by Hannah had to do with bias. She reported experiencing racial bias, and also felt that potential employers showed a bias toward her with regard to her age. She had difficulty securing jobs early on (age 15), and was told that it was because she was too young to have adequate experience. Hannah found this very discouraging, and said that it "happened multiple times."

Pathways. Museums were a very positive environment for Hannah, and she felt that they matched her more independent and self-directed learning style. She also described traveling with her family as an important experience that contributed to her understanding of the world and the many options available as a career:"They (family trips) were influential in my life, because I learned well. That's like a field trip to me."

Her mother was instrumental in encouraging Hannah's interest in medicine, encouraging her to explore the possibilities and describing options, like pediatric nurse or

nurse practitioner that might be suitable. Hannah stated that her mother inspired her to become a doctor.

Hannah participated in Girl Scouts, and she cites this experience as being very important in building her confidence in her own abilities.

Identification of themes

Following completion of student interviews, several rounds of coding revealed themes that appeared repeatedly in the data. These were found to be: a sense of belonging, a desire to help others, certain pivotal life events, the importance of a role model or mentor, the idea of self-directed learning, their perceived level of control, and access to practical information and experiences. These themes reflect the factors that interview subjects felt were most influential upon their decisions concerning a career path.

Conclusions

Perhaps the overarching lesson brought home by this research is the idea that career choice, like other aspects of our development, is influenced by a complex set of factors. In interviewing both males and females with a range of subject interests, the study provides some suggestion of factors that may be important for girls with an interest in STEM, but it also demands that more targeted investigation be undertaken.

Examination of the survey and interview data provided some insight into the experiences of the student participants. What follows is a discussion of the results using the framework of the nine major themes and areas identified through analysis.

Sense of belonging. The importance of feeling a part of things has long been known to be essential for student success (Baumeister & Leary, 1995). A sense of

belonging and school connection are proven to have a positive impact on student motivation, behavior, and attendance, all of which contribute to improved academic performance. This is borne out by the results of this study, and is particularly evident in the interview data. A sense of belonging was mentioned in several instances, in relation to feeling wanted at school, as well as being among "like-minded" people in other settings, such as scout troops and sports teams.

Desire to help others. Interview data revealed a tendency toward community service among several participants. They described several ways in which they helped others, and credit those experiences as being helpful to their own growth in their chosen field. Several respondents said that the desire to help others motivated them to work harder; as one subject put it: to seek "skills that were an asset to me so that I can be an asset to others."

Pivotal events. Six of the eight students interviewed mentioned specific events that heavily influenced their career plans. They were each able to identify a particular time when they felt sure of what occupation they would like to pursue, and sure of their fitness for that pursuit. Many of these events had to do with family members, and in three instances they involved meeting an inspiring person. These people were peers and professionals. The timing of these encounters and pivotal events was important, and they tended to occur at a young age. For example, BEN was adopted at age 7. Frank spent a couple of hours with a technician from Best Buy at age 6, and IYES witnessed her sister's birth at age 3.

Role Models and Mentors. The importance of mentors has been noted in previous studies of the STEM gender gap, and the lack of female mentors in industry and

higher education continues to be an issue. In this study, survey participants reported being heavily influenced by adults in their lives, with parents and teachers most often selected. In interviews, family members were often mentioned as being important role models. For example, Anna described feeling some tension between her desire to become a surgeon and her equally strong desire to be a mother. She cites her mother as a role model. Dan interest in computer programming was affected by his brother's enthusiasm for gaming, and Frank looked up to his older cousin, who "validated" his interest in computers through demonstrating his own interest. When asked what resources or opportunities they would have liked to have growing up, two of the students interviewed cited the lack of a mentor as a barrier.

Self-directed learning. Self-directed learning can be defined as learning that is undertaken through the learner's own initiative. The topics, pace, nature, and course of exploration are all up to the person who is learning, and the learner is free to pursue resources and ideas that interest her or him. Having opportunities to explore their interests independently was one of the ways that students felt encouraged in developing their career goals. Five of the eight students interviewed made mention of self-directed learning as a positive influence.

This type of learning was a mode of self-expression, and helped students to explore their identities as well as their interests. In describing his experiences in theater, BEN said that participation there gave him opportunities to explore other identities through the characters he played: "After I know something about the character, I'm able to live vicariously…it gives me a little more freedom." Hannah expressed appreciation for museums and libraries because they "encouraged questions and exploration."

Sense of Control. A sense of self-efficacy and of having a say in their own career path arose as an important factor for study participants. Being able to feel confident about pursuing their chosen field was tied to having a broad knowledge of potential occupations and opportunities for leadership. The most frequently selected activities on the survey, including school clubs, sports, and summer camps also provided these opportunities. Carl described the value that he found in playing on a basketball team, saying it "taught me discipline, humility, hard work, both physical and mental." Anna mentioned several experiences that helped her to understand the different occupations available in medicine, including her interactions with a team of doctors who helped her through a health crisis. The information she gained from that informed her choice of major in college.

Need for Practical Information. Interview subjects expressed a desire for more practical information regarding specific occupations and what qualifications they require. When asked what resources or opportunities she would have liked to have growing up, Anna expressed the wish for "programs in high school that help you explore careers and get and idea of what's out there." Hannah would have like to know more about higher education, particularly with regard to developing study skills: "I didn't know how to study before college. …in college you can't wing it. You can't try. You can't do it the night before. You'll be hurt."

Barriers. The barriers identified by students completing the survey included family expectations, lack of resources, and peer pressure. In the follow-up interviews students described hearing negative comments from parents and peers. These had a considerable impact on the students' measure of their own capabilities. Two of the eight

students identified a lack of resources as a major barrier in their pursuit of their chosen field.

Interviews also uncovered two other factors that can act as barriers. These were discrimination and learning challenges. Half of the students interviewed mentioned some sort of discrimination as being a part of their experience that they felt impeded their pursuit of their intended career. Gayle, who attended what she considered to be a repressive private school, said that the bias there against the sciences was a major barrier for her in pursuing her interests. Hannah described experiencing gender bias as a barrier when a significant adult in her childhood consistently denigrated anything that he deemed "girly." Gender discrimination was discussed by Frank, who is a male computer science major. He felt that the female students in his programming class were given unfair preferential treatment as a result of a program designed to encourage their participation in STEM.

In some cases, the issue was discrimination against their chosen field. For example, BEN, who majors in mathematics, reported often hearing negative comments about math, and as a result felt doubtful about his chosen course. Carl reported being discouraged by his impression that others felt that his choice of major (Media Arts) was impractical and unrealistic. He recalled people telling him that he was "in over your head. Definitely a façade, or a mirage, or some sort of fake world I'm living in."

Positive Experiences. Perhaps the most valuable information gained through this exploration has to do with what experiences students found most encouraging as they explored their career goals. Every survey respondent was able to identify multiple influences that helped them to clarify their goals, explore new possibilities, and build

their confidence. Based on the interview data, several statements can be made about this sample:

- Parents, home environment, and family expectations are all significant factors in facilitating students' exploration of career options.
- Activities that encourage self-directed exploration as well as provide opportunities for leadership are seen as most valuable.
- Personal connections and a sense of belonging are essential in creating a foundation that supports growth.

Increased understanding of the impact of a range of experiences upon the career aspirations of our youth can be a useful tool for several stakeholder groups. The activities, people, environments, and barriers that students themselves deem significant can provide a helpful framework for developing this understanding.

Chapter 5 -Implications and further research

This study's exploratory approach provided an opportunity to examine the perspectives of undergraduates without preconceived ideas about what those would involve. An online survey and follow-up interviews were conducted with students from both genders and various major fields of study. The survey included 121 participants, and eight follow-up interviews were conducted. Data were gathered related to the subjects' cognitive style, demographics, and to specific experiences and influences that had an impact on their choice of career field. The responses on both the survey and interviews provide a picture of which factors were considered significant by the students themselves, in terms of their development of career interests. This chapter discusses how the themes identified through the study are related to ideas found in the examination of the literature, and in what ways this study adds to our knowledge on the topic. It goes on to discuss the real-world implications of this new information, and how it can inform the work of various groups concerned with encouraging girls with an interest in STEM to persist, and eventually help to close the gender gap in STEM professions. The chapter concludes with discussion of further research that can build upon the ideas encountered in the current study.

Impact

The results of this study support several ideas encountered in the literature. This is particularly true with regard to the research in the field of Educational Psychology. Work in this field has helped to clarify the web of factors that contribute to the STEM gender gap, and to the high rate of attrition from STEM programs among female students. Of

particular interest is the relationship between this study's findings and previous research into some of the major themes that it revealed.

A sense of belonging. One major theme arising from the interview data was the importance of feeling accepted and cared for in different environments. A sense of belonging has shown in study after study to be essential for healthy development as well as academic success (Baumeister, 1995). In their research specifically targeting women's reasons for leaving STEM fields, Grunspan et al (2016) identified the lack of a sense of belonging as a major factor in attrition, along with the decision to start a family, and confidence that one can succeed in the chosen profession.

The current study reflects the current research showing that a sense of belonging is just as important during early years as it is to those already in STEM fields. Depending on individual circumstances, it can be a lifeline that enables healthy development. Feeling as though he belonged and was wanted at school was vital to the success of BEN, for example, who felt that "teachers were the only people in my life who cared for me."

Role models and mentors. The literature shows that a shortage or lack of female mentors and role models is one factor that contributes to the STEM gender gap (Hill, 2010). The current study certainly bears that out. On the survey, female respondents listed more influential people than did males, which indicates that other people were seen as significant influences by the girls. In interviews, students mentioned peers and family members, but also referred to teachers and professionals who took an interest and provided encouragement. For example, Anna was greatly influenced by her interaction with a team of doctors during a health crisis. This stimulated her interest in medicine and helped her to decide on her major field of study.

A sense of control. The level of control that subjects felt with regard to their career decisions was another theme that emerged in the interviews. Interview subjects cited opportunities for leadership, such as being a captain for a sports team or leading a summer camp group, as being helpful and positive experiences. Another factor that enhanced a feeling of control among interview subjects was access to information about how to move ahead in pursuing their goals. Knowing, for example, that it was possible to take college courses in high school was cited by Gayle as a way to take control over her career path.

Feeling that they have little control over their own learning and career path is a very negative state in which some young people find themselves. Dweck (1973) did groundbreaking work on the impact of what she calls "learned helplessness" upon children and their learning. It is an important factor in how persistent learners are:

> …giving up may reflect their perception of independence between what they do and what happens to them. Even though failure may indeed be contingent on their response, they may not see it as such. For example, a child might perceive independence between his response and failure by attributing the outcome to the influence of some external agent; he might perceive independence between his response and outcome by attributing the outcome to his inability to perform the response, whether this is true or not. In either case, he views the situation as being beyond his control. (p.110)

This feeling of having no real control over outcomes may be an important factor in decisions by female students to abandon STEM. It has its roots in Implicit Bias. In many cases the strongest limiting factor may be our own ideas –conscious or otherwise-

about what we are capable of doing. Our own Implicit Bias can create barriers and give the impression that certain pursuits are inappropriate or out of reach. As discussed in Chapter 2, this is an unconscious bias that results from the fact that all humans harbor prejudices of which they are not aware but nevertheless influence their choices and behavior. It can have a harmful effect on young people, whether the biases are held by the adults in their lives or by the youth themselves.

An individual's own Implicit Biases can be a powerful foe in their pursuit of academic and career goals. A recent study found that, around the age of six, girls begin to associate a high level of intellectual ability with being male (Bian, 2017). It found that at the age of 6, girls become less likely than boys to believe that members of their gender are high in intellectual ability ("really, really smart"), and that they begin, at this age, to avoid activities that they perceive as being for those with high intellectual abilities. Gender stereotypes about intellectual ability emerge early and influence children's interests. In the present study, Implicit Bias subtly impacted the interactions students had with teachers, parents, and peers, with some interview subjects mentioning these, and the influence they had upon the subject's own ideas about what an appropriate or realistic career goal was for them. This theory, along with Radical Change and Social Interdependence theories, informed the current study, but separate coding rounds were not conducted based on each of them. Nonetheless, in vivo coding did reveal the influence of Implicit Bias upon two interview subjects in particular: Anna expressed some conflict between her desire to be a surgeon and her ability to be a mother, and Frank struggled with his parents' bias against gaming as a worthwhile pursuit.

Learned helplessness and Implicit Bias are closely related to an individual's perception of their own competence, which is referred to as self-efficacy. This is a person's appraisal of and confidence in their own capacity for choosing actions and carrying them out for specific purposes. Research indicates that self- efficacy may affect achievement in powerful ways (Bandura, 1986). Individuals with higher self-efficacy tend to have higher aspirations, are more committed to their goals, and are able to recover more quickly from setbacks than do those lower in self-efficacy. How capable a person believes herself to be in turn contributes to a sense of personal agency. This is a feeling of control and choice; the sense that one is up to managing any task that presents itself, and, indeed, has some say in what tasks will be undertaken.

The current study suggests several ways in which personal agency can be encouraged and strengthened. Several interview subjects mentioned the value of being able to pursue interests on their own. Taking charge of their own learning empowered them to shift their expectations and develop a stronger sense of personal agency and control. Environments like museums and libraries were named as being places where this sort of independent exploration and questioning is encouraged. Interview subjects also saw value in spending time with others who shared their interests through a wide array of activities, including gaming competitions and theater camps. School clubs and other semi-structured activities were frequently selected on the survey as well.

Implications

The findings of this study may be useful to those whose work has an impact on the development of children, as well as those with a stake in developing the future workforce. This encompasses a broad range of people, starting with teachers, then

expanding quickly to include counselors, as well as industry members such as employers, creators of educational games, and software developers.

Education. Understanding the importance of promoting a strong sense of control and self-efficacy among students can inform the work of educators, and this was a significant finding of the current study. This can be related to the work of psychologists Mueller and Dweck (1998), who conducted a series of studies that examined how praise and encouragement impact individual motivation and academic achievement (Mueller & Dweck, 1998). Their work explores the reasons why some students persist in difficult tasks while others do not, and the current study's findings about the importance of student self-efficacy support those ideas. Dweck goes further, in collaboration with Yeager, specifying an instructional tendency that is damaging to self-efficacy, particularly in female students.

What Dweck and Yeager call "fixed mindset" can develop when students are praised and flattered for how easily they completed a task, and this can make them afraid to tackle more challenging topics and tasks. They begin to see their ability as fixed, meaning that if something is not easy to learn it must be beyond their capabilities. A fixed mindset damages motivation and confidence, since the student does not expect to succeed at tasks that are outside of their comfort zone, and they are therefore not motivated to persist. They fear that having to work hard on a task makes them "look dumb." They expect success with a certain level of effort and have not gotten into the habit of pushing themselves beyond that. In these cases it may be that effort is seen as signaling a lack of natural talent.

On the other hand, a growth mindset comes when students are encouraged to learn from their mistakes. Students who are praised for their process, strategies, and effort feel more confident about tackling difficult tasks and topics, because mistakes are expected, and the use of strategies and procedures is as much a goal as any final product or test score.

While this idea of encouraging a growth mindset has many implications for the classroom, and for students of any gender, some additional information described by Yeager and Dweck in 2012 is pertinent to the present study, and to the discussion of what is behind the STEM gender gap.

That study found that the type of praise given to children differs along gender lines (Yeager & Dweck, 2012). Teachers in their study tended to praise boys for their process more than their intelligence, while girls tended to be praised for doing things well without much effort. The study attributes this to the fact that, in many cases, boys are more immature and harder to engage. As a result, teachers tend to focus their comments to the boys on the importance of paying attention and putting forth more effort. Girls, who are generally better-behaved in the classroom, don't get that sort of feedback. Rather, they more often receive praise for completing tasks with relatively little effort.

Yeager and Dweck suggest that this leads to the boys developing a growth mindset, which is the belief that they can improve their skills and understanding through persistence and hard work. Without this belief, students tend to give up on difficult tasks. Their study suggests that encouraging the development of a growth mindset among girls may be one key to helping them to persevere in challenging subject areas like those in STEM.

Industry. STEM industries and employers have a stake in encouraging more students, regardless of gender, to pursue occupations requiring a background in areas like mathematics, engineering and information technology. The current study's findings related to the importance of a sense of belonging and of access to mentors are both worthy of note for these stakeholders.

Creating an atmosphere that is inclusive and ensuring that new professionals are encouraged and guided by mentors would go long way toward improving retention in STEM professions. In an industry not known for its "soft-skills," such as effective communication and an ability to work collaboratively, this may mean taking deliberate steps to change organizational culture in order to reach and include non-traditional groups in STEM. Efforts to connect with young people investigating STEM occupations would help to promote a sense of belonging, and would also meet the need expressed by study participants for more practical experiences and information on potential professions.

Employing a more inclusive approach in the design of software and educational games will also enhance their effectiveness. So-called "girl-centric design" uses findings from research to create programs that engage female students and other groups not traditionally represented in STEM. This is essential, both to develop needed skills and to provide these students with a sense of ownership and belonging in STEM.

Future research

The exploratory nature and small sample size mean that the current study is not generalizable, but it does provide information that may help in designing future, more extensive and targeted studies.

The findings of this study, along with the consideration of related literature, indicate that there is much further research needed into the reasons behind the STEM gender gap, particularly from the student's point of view. This section describes some avenues for future inquiry, with emphasis upon exploring themes of belonging, agency, and mentorship.

Cross-discipline opportunity. The topics mentioned above provide an excellent opportunity for interdisciplinary work. Library and Information Science is one standpoint for examining activities and experiences that motivate and empower young people to pursue their interests. Libraries and other cultural institutions are in the business of connecting people with information and extending their reach. Other disciplines, such as Social and Educational Psychology, focus on how our experiences shape development and affect learning. Research in Education often involves the examination of specific factors impacting motivation and academic performance, and these can provide insight into how the STEM gender gap came to be and what strategies might be effective in correcting that gap.

As discussed earlier in this chapter, topics in those disciplines, such as Implicit Bias and self-efficacy, appear to heavily influence the career choices made by young people. They played a part in the development of the STEM gender gap and contribute, to some extent, to its continuation. An examination of the interaction of these two factors would be instructive, and would be useful in better understanding the impact of teaching a growth mindset, as described by Dweck. The findings from Bian (2017) regarding the Implicit Biases of young female students could be a starting point for research that looks for connections between bias levels and student mindset. As the research has shown,

Implicit Bias is "malleable." Instructional approaches may be a powerful tool for amending Implicit Bias that has the potential to be harmful.

Also interesting here is the fact that, while Bian found that girls saw a high level of intelligence to be a male attribute, the problem identified by Dweck was that girls were being told that they are "smart." Being praised for intelligence happened much more often with girls in her study. So given the idea that girls as a group may consider themselves less likely to be highly intelligent merely by virtue of gender, this creates a confusing mixed message. The girls do not feel smart, but they are told that their success is due to their intelligence. It would be very interesting to explore this dichotomy, and to determine what part it might play in what is called "imposter syndrome." This is a commonly reported feeling among women in traditionally male professions in which one lacks confidence in their own fitness for their occupation, and expects to be "found out" or exposed as being less competent than they appear (Langford & Clime, 1993).

These elements cross disciplinary lines and their study would bring together findings and theory from a range of researchers. It is necessary to have this sort of interdisciplinary approach in order to understand how they combine to make entry into STEM more difficult for female students.

Mentorship. As mentioned in Chapter 3, part of the data gathering process for the current study involved an interview with an established female STEM professional (LC). The responses from that interview underlined the importance of mentorship to her success in a male-dominated field. LC framed her description of her career with important contacts, friends and mentors who contributed to her success.

LC was influenced by family members in her childhood, when an aunt went to work for IBM. This made her aware of opportunities and occupations that were open to her, and inspired her to find a field where "I can travel and talk to people." She credits her high school librarian with encouraging her to major in Library and Information Science, and once her career began in earnest, a series of professional mentors helped to guide her decisions. As she completed her MLIS, LC was encouraged by three professors in particular to continue on to a PhD. These were all males, and LC mentioned several other male mentors, as well as a number of important female mentors.

So while the interview reinforced the notion that mentorship is very important to women in STEM, it also raised the question: Does the gender of mentors necessarily matter? In other words, is it necessary for a young woman to have female mentors in their profession, or is the quality of the relationship much more significant? This question is separate from the idea of role models, who are not necessarily people with whom one interacts personally. Girls need to see women in the STEM professions and on faculties in order to better picture their future selves in those positions. Mentors, on the other hand, act as guides and advocates, making introductions, developing critical skills, and pushing their protégées beyond their comfort zones. More research on just what makes for an effective mentor, and how important gender may be in the equation, particularly for girls in STEM, would strengthen our ability to provide young people with the support they need for success in whatever field they pursue.

Summary and conclusion

This exploratory study helped to clarify our understanding of what factors students themselves see as being influential in their choices with regard to career path and

major fields of study. While limited by its reliance on convenience sampling, the investigation yielded useful information on variables that bear further study. The data support previous findings with regard to the influence of the students' sense of belonging and control as well as the importance of early mentoring and exposure to the world of work.

There were some snags and obstacles encountered in the course of conducting the study. One significant improvement that could be made would be a revision of the survey questions. For items asking students to choose activities, environments, or people who were influential to them, it would be more useful to create a separate question for each response. For example, rather than asking what experiences they found significant and providing a list of choices, it would be better for purposes of analysis to ask respondents to rate the significance of each experience on a Likert scale. This would provide a numerical value associated with each individual experience.

Another challenge arose in scheduling follow-up interviews. Despite the fact that no incentives were offered, 49 of the 121 survey respondents indicated a willingness to complete a follow-up interview by providing contact information. A first round of contact yielded five scheduled interviews. Reminders were sent one day prior, and four of those went on as scheduled. The fifth student was not available at the scheduled time, but completed the interview at a later date. Three weeks after the initial email seeking to schedule an interview, a second round was sent to the remaining pool of 44 subjects. This resulted in the scheduling of 3 additional interviews. A more extensive study would require some way of incentivizing participation in follow-up interviews to increase the

sample size. It would also be useful to explore the idea of conducting these in person rather than by phone.

To gather more targeted information, direct contact with girls who have an interest in STEM would be most productive. An opportunity for future study will be a summer camp for middle school girls conducted by the University of South Carolina's College of Engineering and Computing. This program provides hands-on experiences and is designed to familiarize girls with the variety of occupations available in engineering.

A surprising theme that arose from the interview data was the desire expressed by most subjects to help others. These students appreciated the fact that they enjoyed advantages that others do not, and they felt an obligation to contribute to the betterment of their communities. They are intent upon a career that allows them to accomplish this in their work. This is interesting in that it echoes some of the tenets of Positive Youth Development (PYD), which is closely related to resilience and includes community engagement and service as an important component of healthy development (Masten, 2014). Youth involvement in community service has many positive outcomes, including academic success and increased personal responsibility, as well as a sense of belonging, connectedness, and self-efficacy (Jones, 2013).

This information makes the case for continued efforts to provide youth with opportunities to contribute to society in tangible ways, enhancing their development and providing a solid foundation for the pursuit of their chosen field. Community service opportunities are offered in an array of organizations, such as scouting and 4-H, as well as school clubs, sports teams, and church groups. Community groups provide programming designed to encourage student involvement and the development of

leadership skills. Students can make a difference by volunteering in their community – participating in food drives, Special Olympics, community cleanup projects, and peer tutoring are all widely available options.

Many school districts embed service learning into the curriculum, providing students with insights and lessons that extend far beyond the curriculum. These projects encourage the development of skills such as problem analysis and critical thinking, and they also contribute to more positive relationships with faculty, improved communication skills, and an enhanced sense of self-efficacy (Eyler, 2001). Given the evidence examined in the current study, it is clear that these effects are essential for encouraging youth to pursue their interests and thrive in an academic setting.

Overall, the present study was useful in suggesting which avenues of study might be most fruitful for investigating the many reasons for the gender gap in STEM professions. Considering the experiences and viewpoint of the students themselves helps to enrich our understanding and ensure that efforts to narrow the gap are well-targeted and relevant.

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Appendix A –Survey Pilot Results

Pilot (n=5)

Last Modified: 03/01/2016

1. Dear Participant: Thank you for agreeing to participate in this survey. Your responses will be used to judge the effectiveness of the survey for use in a larger study. Please elaborate on your responses when appropriate, to provide more details. PLEASE SELECT YOUR 6 DIGIT CODE:

#	Answer		Response	%
1	IYEP00		0	0%
2	IYEP01		0	0%
3	IYEP02		1	20%
4	IYEP03		1	20%
5	IYEP04		1	20%
6	IYEP05		1	20%
7	IYEP06		1	20%
	Total		5	100%

Statistic	Value
Min Value	3
Max Value	7
Mean	5.00
Variance	2.50
Standard Deviation	1.58
Total Responses	5

2. What is your gender?

#	Answer		Response	%
1	Male		1	20%
2	Female		4	80%
3	Prefer not to Answer		0	0%
	Total		5	100%

Statistic	Value
Min Value	1
Max Value	2
Mean	1.80
Variance	0.20
Standard Deviation	0.45
Total Responses	5

3. What year were you born?

#	Answer		Response	%
5	1996		1	20%
6	1995		1	20%
7	1994		3	60%
97	1904		0	0%
	Total		5	100%

Statistic	Value
Min Value	5
Max Value	7
Mean	6.40
Variance	0.80
Standard Deviation	0.89
Total Responses	5

4. What is your race?

#	Answer		Response	%
1	White/Caucasian		3	60%
2	African American		1	20%
3	Hispanic		1	20%
4	Asian		0	0%
5	Native American		0	0%
6	Pacific Islander		0	0%
7	Other		0	0%
	Total		5	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.60
Variance	0.80
Standard Deviation	0.89
Total Responses	5

5. What is your academic classification?

#	Answer		Response	%
1	Freshman		0	0%
2	Sophomore		1	20%
3	Junior		2	40%
4	Senior		2	40%
5	Graduate		0	0%
	Total		5	100%

Statistic	Value
Min Value	2
Max Value	4
Mean	3.20
Variance	0.70
Standard Deviation	0.84
Total Responses	5

6. Please select your major.

#	Answer		Response	%
1	Accounting		2	40%
77	Library and Information Science		2	40%
102	Psychology		1	20%
	Total		5	100%

Statistic	Value
Min Value	1
Max Value	102
Mean	51.60
Variance	2,237.80
Standard Deviation	47.31
Total Responses	5

7. Which best describes your High School?

#	Answer		Response	%
1	Public		4	80%
2	Public - Magnet		0	0%
3	Private		1	20%
4	Home-Schooled		0	0%
	Total		5	100%

Statistic	Value
Min Value	1
Max Value	3
Mean	1.40
Variance	0.80
Standard Deviation	0.89
Total Responses	5

8. Where was your High School located?

#	Answer		Response	%
21	Maryland		1	20%
31	New Jersey		1	20%
33	New York		1	20%
41	South Carolina		2	40%
	Total		5	100%

Statistic	Value
Min Value	21
Max Value	41
Mean	33.40
Variance	68.80
Standard Deviation	8.29
Total Responses	5

9. Which category best describes your intended occupation?

#	Answer		Response	%
5	Business and financial operations		2	40%
8	Computer or mathematical		1	20%
18	Health care support		1	20%
25	Office or administrative support		1	20%
	Total		5	100%

Statistic	Value
Min Value	5
Max Value	25
Mean	12.20
Variance	79.70
Standard Deviation	8.93
Total Responses	5

10. When you were growing up, what occupation(s) did the adult(s) in your household pursue?(please choose all that apply)

#	Answer		Response	%
1	Management: professional or related occupations		1	20%
2	Management: business or financial operations occupations		1	20%
6	Business operations specialists		1	20%
12	Community and social services		1	20%
14	Education, training, or library		2	40%
16	Health diagnosing or treating practitioners & technical occupations		1	20%
18	Health care support		1	20%
23	Personal care or service		1	20%
32	Supervisors, transportation or material moving		1	20%

Statistic	Value
Min Value	1
Max Value	32
Total Responses	5

11. In which of the following have you participated?(please choose all that apply)

#	Answer		Response	%
1	Scouting		3	60%
2	Science Fairs		0	0%
3	Summer camps		4	80%
4	School clubs		5	100%
5	Church groups		3	60%
6	Internships		2	40%
7	Sports		4	80%

Statistic	Value
Min Value	1
Max Value	7
Total Responses	5

12. What aspects of the above activities were most helpful to you in developing your skills and interests?

Order of response:04,03,05,06,02

Text Response
Internships, church groups, sports
organization, motivational aspects, achievement of success
Team building, and problem solving. I enjoyed coming up with solutions to difficult problems in clubs and sports teams
I learned to be more sociable. Learned how to open up more about myself and observe a new environment I've never been in.
With all of these activities I was able to help me to interact with kids my age and older. I was able to build relationship and just experience a lot of different things through the years.

Statistic	Value
Total Responses	5

13. Which of the following have influenced your career plans?(please choose all that apply)

#	Answer		Response	%
1	Teachers		4	80%
2	Parents		5	100%
3	Other family		1	20%
4	Peers		2	40%
5	Group leaders		1	20%
6	Employers		0	0%
7	Others		1	20%

Statistic	Value
Min Value	1
Max Value	7
Total Responses	5

14. Please describe how these people influenced you.

No response: 03

Text Response
Watching my parents go into business.
My teachers and parents have always encouraged me to pursue a career I can both enjoy and make a living in. Game designers and online personalities have kindled my passion for programming and development.
I learned about Information Science from my friend and it sounded like something I really wanted to get into. My parents have always supported me in whatever it is I want to do in life, and the teachers here make me want to learn more about Information Science and what I can do with it.
The would tell me that im able to do anything i put my mind to as long as i keep in the right path and dont let anything block my vision. They gave a lot of encouraging word.

Statistic	Value
Total Responses	4

15. Which of the following do you feel had an impact on your career choices?(please choose all that apply)

#	Answer		Response	%
1	Museums		0	0%
2	Libraries		0	0%
3	Travel		3	60%
4	Hobbies		4	80%
5	Home atmosphere		4	80%

Statistic	Value
Min Value	3
Max Value	5
Total Responses	5

16. Please describe your exposure to the factors above, particularly with regard to how they affected your awareness of your personal interests.

Text Response
I saw that I enjoyed learning about business.
Opened eyes to interests in business by exposure
My home atmosphere was very supportive of my interests and hobbies, so I spent a lot of time analyzing media and practicing programming.
My friend lives with me in our apartment, so she tells me all kinds of neat things about Information Science.
Traveling around the world helped because i was able to see that people need more medical attention than the media portrays and its sad. I started volunteering and jsut seeing how sad people are in hospitals made me realize that i have to change the lifes of others

Statistic	Value
Total Responses	5

17. What are some barriers that you've faced in pursuing your chosen field?

Text Response
It is very difficult to learn.
competition, complexity of material
I eventually want to get into game development, but it is not the best field. Pay is not necessarily high and jobs are not secure.
Just things like mental barriers, thinking "I can't do this" or "what am I even doing in college" for example.
The fact that im still young anf some teachers at my private school told me i need to change my career feild because my goal is too drastic.

Statistic	Value
Total Responses	5

18. Have you made a major change in career path? When did this occur? What factors led to this change?

Text Response
No
no- declared major beginning of freshman year.
Last year I was a nursing major, I switched because as I took more nursing classes I realized nursing is not what I wanted to do for the rest of my life.
Not that I can think of at the moment.
Yea, ive wanted to be a pediatrician for years but now an addition to that i want to find a cure for cancer. This change occured my senior year in high school due to all the cancer patients that have lost their lives over the years

Statistic	Value
Total Responses	5

ALERT SCALE

	IYEP01	IYEP02	IYEP03	IYEP04	IYEP05
A responses	3	3	2	3	4
B responses	2	4	2	4	2
Totals	5	7	4	7	6
Classification	ML	ML	SL	ML	ML

0-4 Strong Left Hemisphere Orientation (SL)
5-8 Moderate Left Hemisphere Orientation (ML)
9-11 Bilateral Hemisphere Balance (B)
12-15 Moderate Right Hemisphere Orientation (MR)
16-20 Strong Right Hemisphere Orientation (SR)

Appendix B – ALERT Scale Items and Final Survey

Alert Scale of Cognitive Style

Some of the following choices may seem to be either both true or both false. However, please don't check both or leave a
Force yourself to choose the one sentence which is most accurate. These questions will help you discover your personal th
the way you do your work.

1.	I have to have neat, orderly surrounding to work in. (A) I have to have comfortable surroundings to work in. (B)	A _____ OR B _____
2.	Deadlines and schedules make my work easier to do. (A) Deadlines and schedules interfere with the way I work. (B)	A _____ OR B _____
3.	I'm good at analyzing all the different parts of a problem. (A) I'm good at thinking of many different solutions to a problem. (B)	A _____ OR B _____
4.	I'm proud of the creativity of my work. (A) I'm proud of the thoroughness of my work. (B)	A _____ OR B _____
5.	When I take a "break" I relax and do nothing. (A) When I take a "break" I find something different to do. (B)	A _____ OR B _____
6.	I don't think about the time when I work. (A) I plan out my time when doing work. (B)	A _____ OR B _____
7.	I will follow proven ways of doing my jobs. (A) I will find my own way of doing new jobs. (B)	A _____ OR B _____
8.	I prefer to finish one job before starting a new one. (A) I prefer to be working on many jobs at the same time. (B)	A OR B
9.	I can usually analyze what should happen next. (A) I can usually sense what should happen next. (B)	A _____ OR B _____
10.	I do easy things first and save important things for later. (A) I do important things first and other things later. (B)	A _____ OR B _____
11.	Other people think I'm unorganized. (A) Other people think I organize things well. (B)	A _____ OR B _____
12.	I arrange objects so they are off-center and angled. (A) I arrange objects so they are centered and in line. (B)	A _____ OR B _____
13.	I follow an outline when I write a paper. (A) I don't use an outline or change it when I write. (B)	A _____ OR B _____
14.	With a difficult decision I follow what I know. (A) With a difficult decision I follow my feelings. (B)	A _____ OR B _____

15.	I question new ideas more than other people do. (A) I agree with new ideas before other people do. (B)	A _____ OR B _____
16.	I change the way I do a job, for variety. (A) When one way works well, I don't change it. (B)	A _____ OR B _____
17.	I'm usually late. (A) I'm usually early. (B)	A _____ OR B _____
18.	Where I put things depends on what I'm doing. (A) I put each thing in a particular place. (B)	A _____ OR B _____
19.	I'm very consistent. (A) I'm very spontaneous. (B)	A _____ OR B _____
20.	I arrange clothes in my closet by type, length, season, etc. (A) I don't put clothes in my closet in any particular order. (B)	A_____OR B_____

The first section of the final survey was comprised of the ALERT Scale items above. Fifteen additional questions completed the survey, and are listed below.

21. What is your gender?

Male Female Prefer not to Answer

22. What year were you born?

23. What is your race?

24. What is your academic classification?

Freshman Sophomore Junior Senior Graduate

25. Please select your major.

26. Which best describes your High School?

Public

Public -Magnet

Public-Charter School

Private

Home-Schooled

27. Where was your High School located?

28. Did you take STEM classes in high school?

29. Which category best describes your intended occupation?

30. When you were growing up, what occupation(s) did the adult(s) in your household pursue?

31. In which of the following have you participated?

(please choose all that apply)

Scouting

Science Fairs

Summer camps

School clubs

Church groups

Internships

Sports

Other

32. Which of the following people have influenced your career plans?

(please choose all that apply)

Teachers

Parents

Other family

Peers

Group leaders

Employers

Others

33. Which of the following environments do you feel had an impact on your career choices?

(please choose all that apply)

Museums

Libraries

Travel

Hobbies

Home atmosphere

Other

34.Have you faced barriers in pursuing your chosen field or occupation?

(please choose all that apply)

Peer pressure

Lack of resources

Family expectations

Other

35. Follow-up

Greater insight on the topic will be gained through a brief interview, which can look more deeply into individual views and experiences. ***Please consider making a further contribution*** to the data in this way. Interviews can be done by Skype, phone, or email.

If you would be willing to participate in a follow-up interview, please enter your name and email address below. This information will not be linked to your survey responses, which are anonymous.

First Name Last Name Email address

Appendix C - Final Interview Questions

1. Please choose one of these common tasks and provide a detailed description of how you go about completing it. Choices are: grocery shopping, paying monthly bills, and choosing a restaurant.
2. Please tell me about your experiences with different activities outside of the classroom and their influence on your career plans.
3. Please talk about the people who had an impact (positive or negative) on your feelings about the sort of work you'd like to do.
4. Describe some of the environments that influenced your interests and why they are significant to you.
5. What are some biases you've encountered or seen others deal with in relation to who is best suited to work in one field or another?
6. Are there any resources or opportunities you now wish you'd had access to growing up?